California Statewide Travel Demand Model, Version 2.0

Validate Model System and Sensitivity Testing

final

report

prepared for

California Department of Transportation

prepared by

Cambridge Systematics, Inc.

and

HBA Specto, Inc.

July 2014

www.camsys.com

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date

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1.0 Background

This report describes the model validation and sensitivity testing conducted to evaluate the California State Travel Demand Model System (CSTDM) Version 2. Validation checks for the calibration year (2010) allow the model user and developer to evaluate the accuracy of the model and provide more detailed information on potential strengths and weaknesses of the model performance. CSTDM Version 2.0 was validated several ways:

- Assigned model traffic volumes were compared against observed traffic counts at individual locations and along screenlines;
- Modeled transit ridership for local operators and rail services was compared to observed data;
- A Year 2000 "backcast" was run for Year (2000) to validate the model's ability to be used for forecasting a different year; and
- Two additional scenarios, varying a single input each time, were tested to evaluate the model's sensitivity to increases in cost and transit service.

2.0 Model Calibration and Validation Overview

The CSTDM Version 2.0 has five different model components:

1. Short Distance Personal Travel Model (SDPTM);
2. Long Distance Personal Travel Model (LDPTM);
3. Short Distance Commercial Vehicle Model (SDCVM);
4. Long Distance Commercial Vehicle Model (LDCVM); and
5. External Vehicle Trips Model (ETM).

The development of the overall CSTDM Version 2.0 involved four basic steps:

1. **Model specification** – Where the form and structure of each model was identified.
2. **Model parameter specification/estimation** – Where the parameters used in each model were identified or estimated. For the short distance and long distance personal travel models the parameters have been estimated using the 2012 California Household Travel Survey (CHTS). For the other three models, initial parameter values have been obtained from the initial version of these models (called CSTDM09) or were calculated from available observed data.
3. **Model calibration** – Where each model was run for the entire state for the Year 2010 base year, and the model outputs were compared to observed data calibration targets. Parameters for each model were adjusted until a reasonable fit was obtained between modeled and observed values.
4. **Model validation** – Where the output from all models running for the whole state were compared to observed vehicle and passenger flows across screenlines and routes, as well as comparison to other observed data for reasonableness. Additional adjustments were made to model parameters as appropriate, for one or more of the models, until a reasonable fit between model output and observed data for the screenlines was obtained. For the CSTDM Version 2.0, the primary model validation process was executed for the base year (2010) model.

A set of dedicated reports and technical notes provides details on each step of the CSTDM Version 2.0 model development described above. The object of this document is the description of the Model Validation.

3.0 Collection of Observed Data

Observed data were collected from a variety of sources to represent the actual conditions of the transportation system across the state. Several challenges to obtain and analyze observed data occurred, including:

- Data would ideally need to match the assumptions of the model (average fall/spring weekday) for direct comparison;
- The geographic size of the State and number of data points across the state resulted in time-consuming collection and review activities; and
- The reliability of available and published observed was, at times, suspect.

3.1 Vehicle Counts

Total Vehicle Flow

The CSTDM reflects travel conditions for an average fall/spring weekday, and data was collected for those days, where available. Several data sources were consulted to achieve reasonable observed traffic volumes by time of day, as described below.

Caltrans Vehicle Counts

Caltrans collects and maintains hourly traffic counts at various locations across the State. Count stations were identified at locations closest to identified screenline locations, and raw counts at each station for years 1999-2001 and 2009-2011 were extracted by Caltrans staff. CS staff processed the count data to exclude counts on days not occurring on average fall/spring weekdays and those counts more than one standard deviation away from the median in an attempt to remove anomalies in the data.

Caltrans vehicle counts had the advantage of containing information on traffic by time of day and could be queried to represent average fall/spring weekday traffic. However, some counts stations were subject to faulty monitors or inconsistent data; and the count locations did not always match the identified locations along key corridors and screenlines.

Performance Measurement System (PeMS)

PeMS provided historical and real time data from over 25,000 individual detectors, located on freeways across all major metropolitan areas of the State of California and several state highways as well. Aggregate detector plots provide data at many different levels of spatial and temporal aggregation and can be averaged over time of day and days of the weekday. These features allowed CS to aggregate vehicle counts to the CSTDM time periods and query the median traffic flow for those time periods for average fall/spring weekdays.

However, PeMS data was not available at all validation locations; and some data can be questionable due to faulty sensors, traffic disruptions, weather, special events, and other circumstances. Nonetheless, the PeMS data were useful for checking the reasonableness of traffic counts collected for this study.

Caltrans Count Book

Caltrans Traffic Data Branch maintains Annual Average Daily Traffic (AADT) volumes for many state highways at many locations. The count book volumes were useful since historical records going back many years were available, so that traffic trends were readily analyzed. In addition, count book volumes were available for numerous locations on all state highways, providing a comprehensive analytic resource.

Downsides of the count book data were that AADT volumes may not match weekday daily traffic conditions – particularly for areas where weekend travel patterns are different than for weekdays, or where seasonal traffic varies. Locations near popular tourist destinations are typical locations where weekend traffic conditions varies significantly from weekday conditions. Agricultural areas may experience large seasonal variations depending on crop harvesting. Additionally, the count book data does not provide directional or time of day data.

Previous CSTDM09 Assumptions

Year 2008 vehicle counts were already compiled by ULTRANS and HBA Specto for the previous version of the model (CSTDM09) and were used as a readily available benchmark for reasonableness of Year 2010 counts.

Final Observed Vehicle Counts

The data sources reviewed varied in reliability and suitability. No single data source contained all the information needed for every location, but the estimated best information was extracted from the data available.

Year 2010 Caltrans Vehicle Counts were the starting point for the set of observed counts and remained the data source for a large majority of the count locations. Caltrans counts were compared to the year 2008 counts used in the CSTDM09 validation; and where Caltrans Vehicle Counts were not available, seemed unreasonably off from year 2008, or varied greatly by direction over an entire day, PeMS data was used, if available. In a few locations, neither data source provided reasonable traffic counts, in which case the Caltrans Count Book or the CSTDM09 2008 counts were utilized.

Truck Count

Caltrans Vehicle Classification Counts

Caltrans provided vehicle classification counts, which provided hourly vehicles by vehicle type. However, few counts were returned for the queried stations.

Caltrans Truck Count Report

Caltrans maintains a Truck Count Report for AADT at select locations on state highways for trucks, classified by the number of axles. However, estimates may have been based on old data and were not considered reliable enough to stand alone for validation purposes but was used for reasonableness checks.

SCAG Counts

CS developed a truck count database for the Southern California Association of Governments (SCAG), in support of the Heavy Duty Truck (HDT) model update in 2012. The SCAG database included new and recent counts collected for the HDT model update, and from other sources. Some count locations used in that model development effort matched the locations selected for CSTDM validation and were used in this analysis. The SCAG counts were useful in expanding the number of locations with truck counts.

3.2 AUTO TRAVEL CHARACTERISTICS

Vehicle Miles Traveled (VMT)

Highway Performance Monitoring System (HPMS)

HPMS data provides an independent source of data related to aggregated, observed travel data for the entire state. Per direction of Caltrans staff, HPMS data were used for reasonableness checks only and not considered reliable enough for strict validation. The California Public Road Data Report provided information on VMT, maintained miles, and lane miles by county and by facility type.

Congested Speeds

Speed maps provide a quick and easy visual check for reasonable distribution of vehicles and congestion.

Performance Measurement System (PeMS)

PeMS data provided real-time speeds and average speeds, which represent historical average speed for the same time of day. However, graphic representations of average speeds during peak hours seemed to reflect very optimistic travel speeds, as shown in Figure 3.1. Local knowledge of peak period congestion did not intuitively match average speeds displayed in the PeMS data system.

Google Maps

Google Maps provided typical traffic flows by day of the week and time of day, estimated from cell phone data. Although speed thresholds corresponding to the color coding were not documented – the typical traffic maps intuitively seem to better represent congested conditions experienced by drivers in peak periods, as shown in Figure 3.2.

Figure 3.1 Example PeMS AM Peak Period Congested Speeds

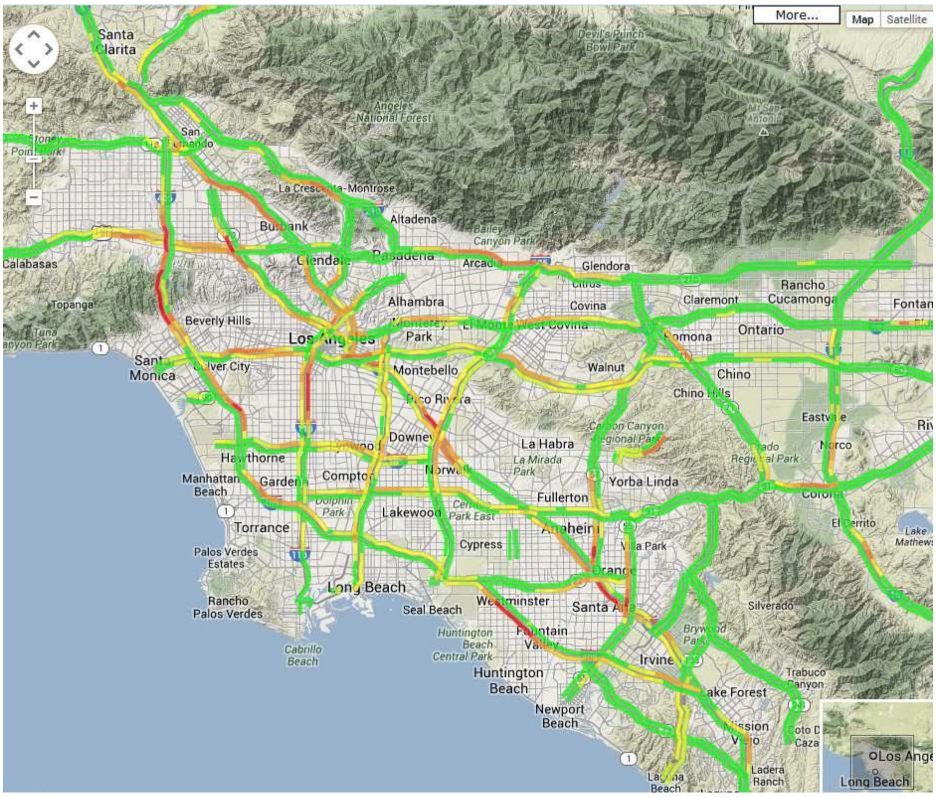


Figure 3.2 Example Google Maps AM Peak Period Congested Speeds

3.3 TRANSIT RIDERSHIP

Local Bus

The National Transit Database (NTD) is the primary source for information and statistics on transit systems of the United States. All transit operators who received grants from the Federal Transit Administration (FTA) are required to submit data to the NTD. The NTD does not provide ridership statistics for all operators in the State of California, but it does provide data on almost all major operators. Average daily riders by operator for the Year 2010 was collected as part of this validation effort.

The Bay Area's Metropolitan Transportation Commission (MTC) model validation documentation for the Year 2010 was also utilized for local bus ridership by operator along specific corridors – Transbay and San Francisco-North Bay movements.

Conventional Rail

Year 2010 ridership and segment loads were collected for the following rail lines and operators:

- Amtrak Pacific Surfliner, Capitol Corridor, and San Joaquin;
- BART;
- Caltrain;
- Metrolink; and
- Coaster

Air

Observed data have been summarized from the U.S. DOT 10 percent origin-destination survey airline data, collected by the Bureau of Transportation Statistics (BTS). Local air trips in the 10 percent survey data were those trips between the identified airports that were not transfers to or from flights to other locations outside of California.

The observed data include non-California residents who had origins and destinations at California airports as well as international travelers who had an initial domestic origin and a final domestic destination at a California airport. Because of the inclusion of non-California residents in the 10 percent sample data, the calibrated model was expected to have fewer assigned air trips than the observed data.

4.0 Year 2010 Validation

The overall model performance was measured by a comparison of modeled vehicle and transit passenger flows to observed flows across defined screenlines and along transportation corridors. A number of other reasonableness checks provided additional points of validation against observed data but did not have accuracy requirements due to lack of comparable assumptions in the underlying data or reliability in the observed data.

4.1 Reasonableness Checks

Travel Times

Evaluation of modeled travel times to observed data provided reasonableness checks and Quality Assurance/Quality Control (QAQC) on network inputs, path-building procedures, and simulated congestion. Skimmed travel times along key corridors were compared to travel times extracted from Google Maps for spot checks along key interregional corridors. Examples of such comparisons can be found in Table 4.1.

For the selected city pairs, the midday auto travel times produced results very similar to the those reported by Google Maps.

Table 4.1 Sample Comparisons of Modeled and Observed Travel Times

Path	Midday Auto Travel Times (minutes)	Google Maps (minutes)	Ratio of Midday Model to Google Maps
Sacramento to Fresno	162	159	1.02
Los Angeles to San Diego	120	118	1.02
Davis to San Francisco	73	76	0.96
Bakersfield to Sacramento	255	249	1.02
Bakersfield to Los Angeles	108	107	1.01
Eureka to San Francisco	298	279	1.07
Redding to Sacramento	145	140	1.04

CHTS reported travel times were compared to modeled travel times for a more aggregate comparison. CHTS data was reviewed to remove outlying records, such as those reporting highly improbable travel times. Because of inaccurate reporting and/or variations in perceived travel time versus actual travel time, an exact match of modeled to survey travel times was not an objective. Differences between the survey reported and modeled travel times is not indicative of bad modeled data.

Comparisons of the travel times were conducted for a reasonableness checking by sorting and investigating the data points with very high differences in travel times. Figure 4.1 displays the final results of all individual comparisons.

Figure 4.1 Comparison of CHTS Reported Trip Duration and Modeled Auto Travel Times

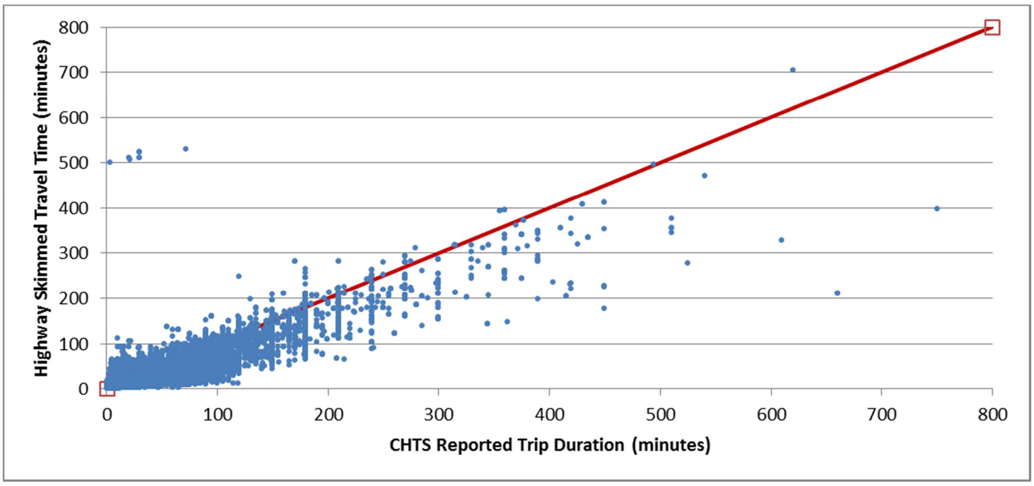


Table 4.2 provides the share of records by difference in stated and modeled travel times, to check for any systematic basis. Table 4.3 separates out those records by length of the trip, in minutes. After investigating the outliers, stated travel times were often much longer on greater distance trips because they likely included various stops along the way in the total travel time, whereas the model only included the driving time directly between origins and destinations.

Table 4.2 Comparison of Auto Travel Times by Time of Day

Highway Skim in Comparison to Stated Travel Time	All Trips	AM Peak Period	Midday	PM Peak Period	Offpeak
Greater than 45 minutes lower	1%	1%	1%	2%	1%
30 to 45 minutes lower	2%	2%	2%	3%	2%
10 to 30 minutes lower	25%	24%	24%	27%	25%
Less than 10 minutes lower	58%	57%	59%	56%	59%
Less than 10 minutes higher	12%	13%	12%	11%	11%
10 to 30 minutes higher	1%	1%	1%	1%	1%
30 to 45 minutes higher	0%	0%	0%	0%	0%
Greater than 45 minutes higher	0%	0%	0%	0%	0%

Table 4.3 Comparison of Auto Travel Times by Trip Length

Highway Skim in Comparison to Stated Travel Time	All Trips	Trips >10 Min.	Trips >30 Min.	Trips >60 Min.	Trips >120 Min.	Trips >240 Min.
Within 5 minutes	42%	23%	14%	10%	7%	3%
Within 15 minutes	85%	77%	43%	30%	24%	11%
Within 30 minutes	96%	95%	79%	57%	43%	22%
Within 60 minutes	99%	99%	97%	89%	71%	44%

Congested Speeds

Modeled congested speeds were plotted for comparison against typical traffic from Google Maps for reasonableness checks across that State. Figures 4.2 through 4.7 show the modeled and independently-sourced speeds in the PM Peak Period for the San Francisco Bay Area, San Joaquin Valley, and the Los Angeles area. Please note that Google Maps were consulted in 2013 and 2014, so comparisons with 2010 model results may not always be appropriate – particularly for areas where major construction or recent roadway improvements may been implemented.

In the San Francisco Bay Area, the model shows appropriate congestion across the Bay Bridge, within San Jose, and along the Peninsula, but less congestion across the Dumbarton and San Mateo Bridges. Although, it is noted though that the speed thresholds for Google Maps are not known, so color mapping could not be assured to match in both scenarios.

Within the Southern San Joaquin Valley and along the Central Coast, both the model and Google Maps show little congestion on a typical weekday in the PM peak period. The project team understands that some local congestion occurs – particularly within the most urbanized parts of cities such as Santa Cruz, Monterey, Salinas, Fresno and Bakersfield. However, the congestion in these areas is not as extensive as in the state's largest major metropolitan areas.

Both the CSTDM and Google Maps show heavy congestion in Central Los Angeles. The CSTDM appears to pick up the most congested locations in central Los Angeles and Orange Counties, particularly along the key north-south freeways – I-5 and I-405. Heavy congestion in the CSTDM also seen along US-101 in Ventura and North Los Angeles Counties, SR 91 between Los Angeles and Empire, and I-15 (also in the Inland Empire). From a visual perspective, the CSTDM seems to perform reasonably with respect to peak period congestion compared with Google Maps.

Figure 4.2 Modeled PM Peak Period Congested Speeds – San Francisco Bay Area

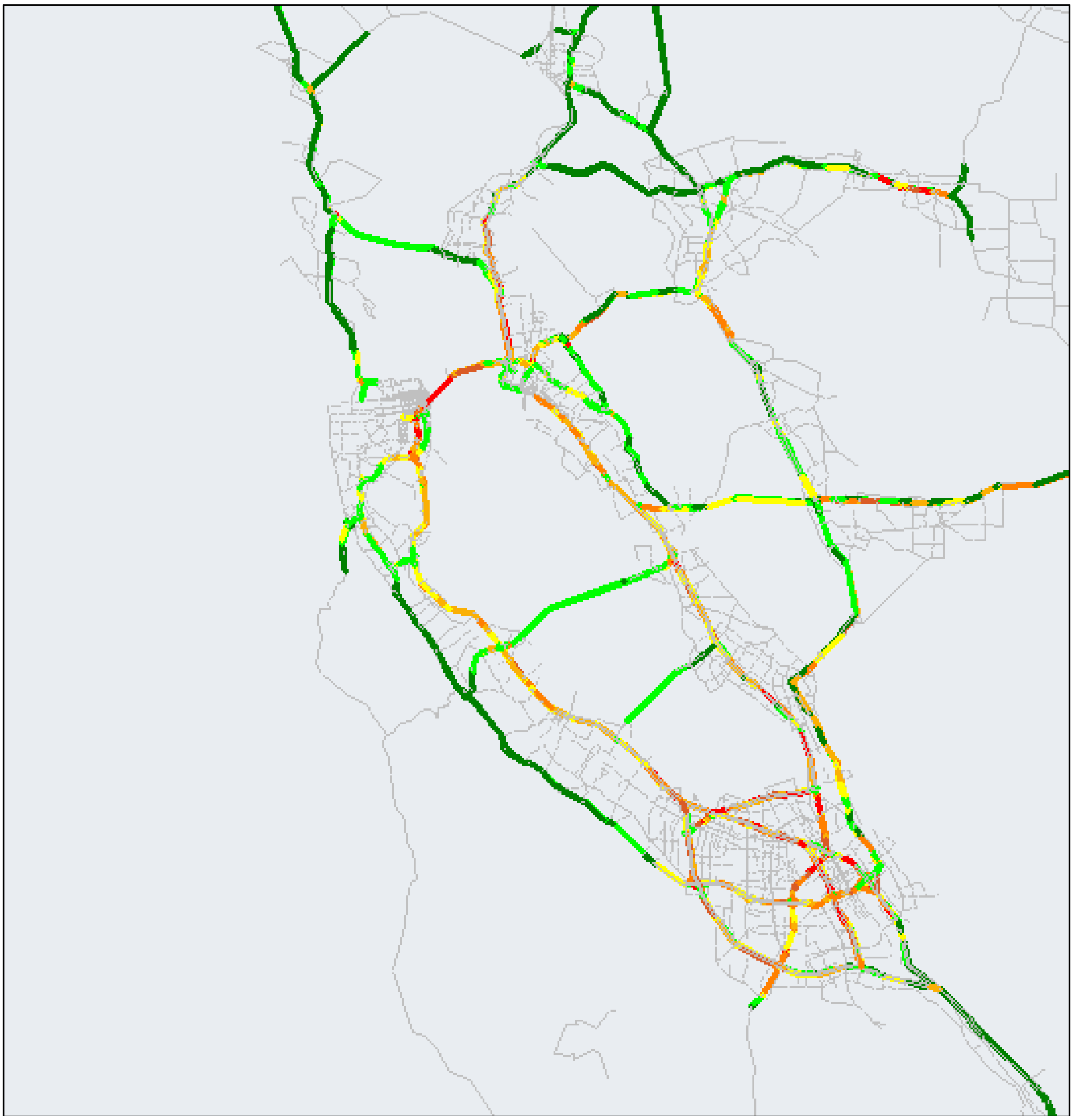


Figure 4.3 Google Maps PM Peak Period Congested Speeds – San Francisco Bay Area

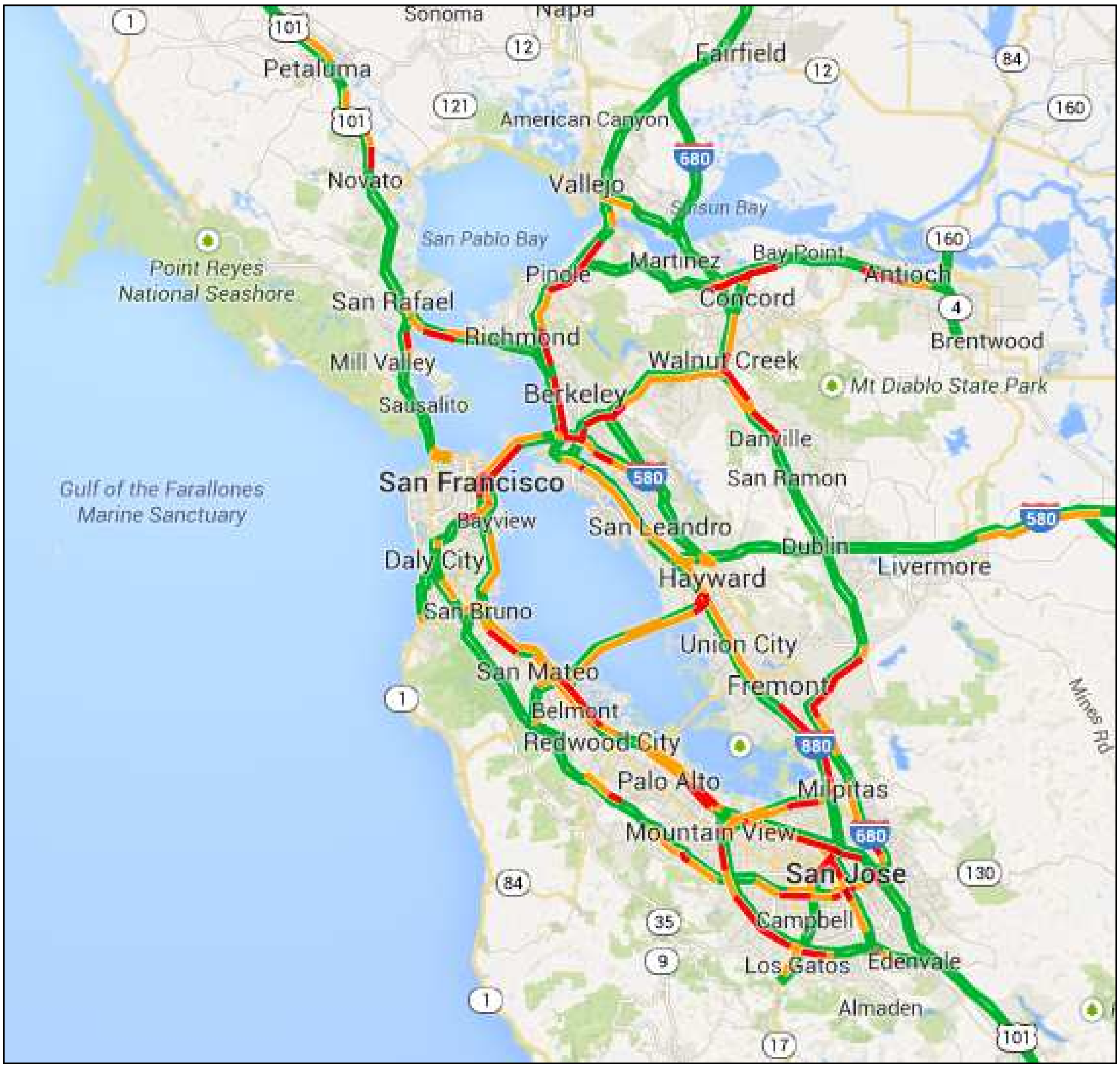


Figure 4.4 Modeled PM Peak Period Congested Speeds – San Joaquin Valley

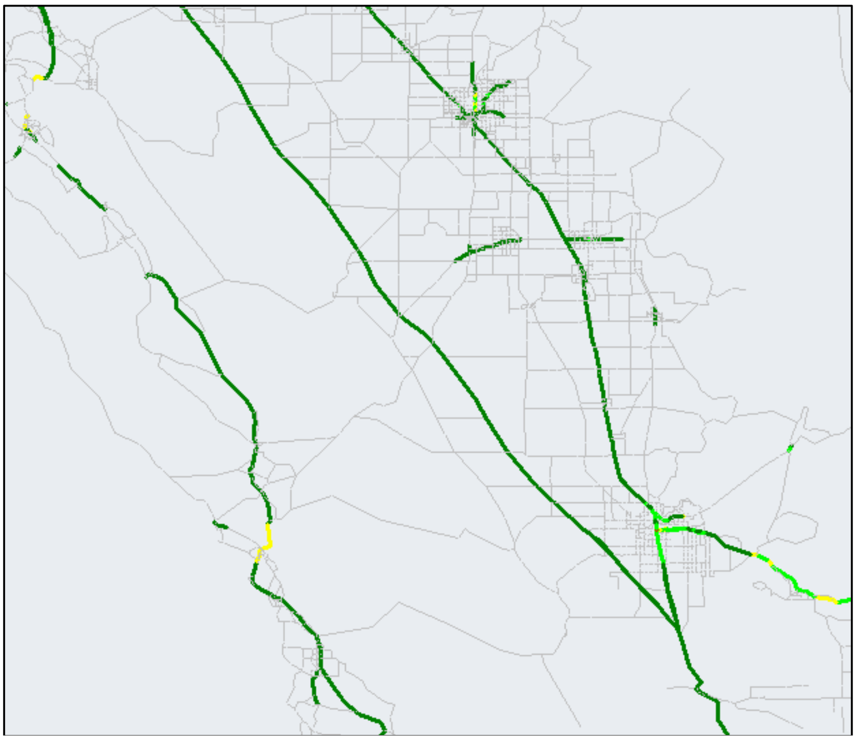


Figure 4.5 Google Maps PM Peak Period Congested Speeds – San Joaquin Valley

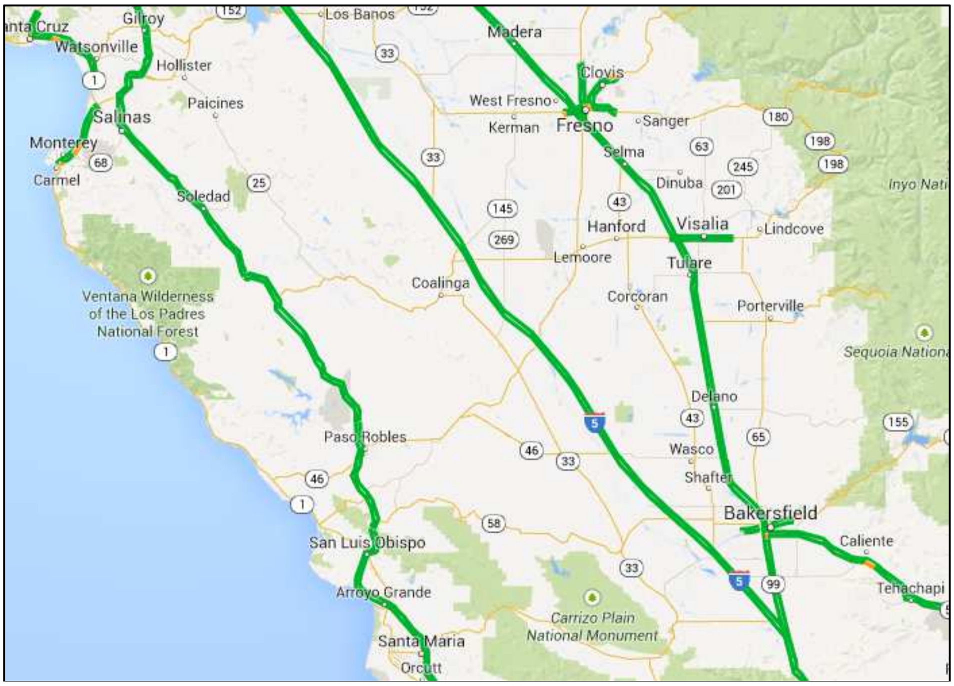


Figure 4.6 Modeled PM Peak Period Congested Speeds – Los Angeles Region

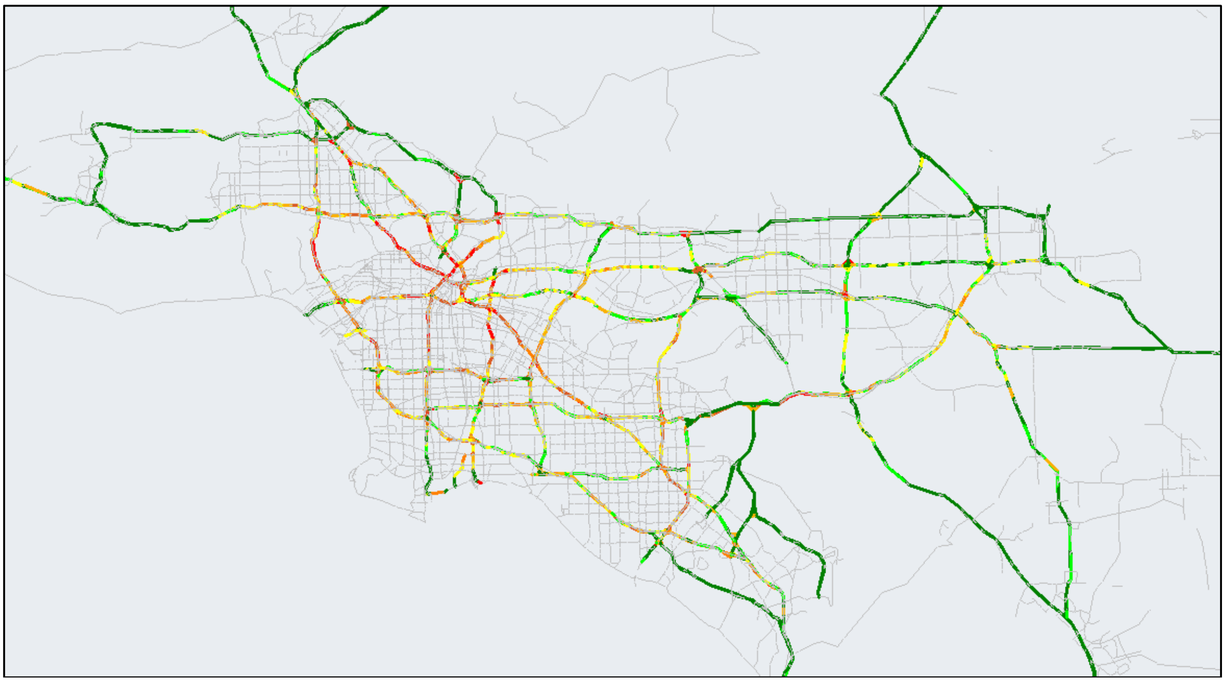


Figure 4.7 Google Maps PM Peak Period Congested Speeds – Los Angeles Region

VMT

Modeled VMT was obtained by summing interzonal VMT for the entire network, including zone centroids to represent access to network, and intrazonal VMT estimated with skimmed intrazonal distances and trips. The total modeled VMT was compared to HPMS for reasonableness, as shown in Tables 4.4 and 4.5. There are a number of reasons for unmatched values of VMT:

- The level of accuracy of HPMS data is not entirely known.
- CSTDM Version 2.0 network did not include collectors and local roads.
- Centroid connector VMT likely underestimates access to highway network.
- CSTDM does not model all types of travelers, such as visitors to the State.

Table 4.4 HPMS and Modeled VMT by Facility Type
Thousands of Miles

Facility Type	HPMS	Modeled	Percent Difference
Freeways, Expressways	371,900	429,000	15%
Other Principal Arterials	210,100	155,300	-26%
Minor Arterials, Collectors, Local Roads	316,000	180,100	-43%
Total	**898,000**	**764,400**	**-15%**

Table 4.5 HPMS and Modeled VMT by Geographic Area
Thousands of Miles

Caltrans District	HPMS	Modeled	Percent Difference
Northwest Coastal Region	13,900	6,300	-54%
North/Northeast	13,700	10,500	-23%
SACOG	67,100	56,200	-16%
Bay Area	158,200	132,400	-16%
North San Joaquin Valley	43,200	30,400	-30%
South San Joaquin Valley	61,700	53,800	-13%
Sierras	3,900	1,900	-52%
Central Coast	36,000	22,100	-39%
Los Angeles	231,300	202,600	-12%
Orange County	71,300	73,800	4%
San Bernardino/Riverside	114,800	94,300	-18%
San Diego/Imperial County	82,900	80,000	-3%
Statewide	**898,000**	**764,400**	**-15%**

4.2 Accuracy Targets

Inherent error exists in both traffic counts and transit ridership as conditions fluctuate from day-to-day. Guidelines are available to evaluate the level of accuracy of the model that allows for this natural variation.

Criteria used to assess the adequacy of the highway assignment included:

- Percent volume deviation by screenline:
  - Evaluated against criteria provided in NCHRP 255; and
- Percent volume root mean square error (%RMSE) by volume group:
  - Evaluated against criteria provided in the ODOT Travel Demand Forecasting Manual – Traffic Assignment Procedures.

4.3 Total Vehicle Flows

Screenline and Count Locations

Screenlines were consistent with those developed and used for validation of CSTDM09, many of which were along interregional and county boundaries. These movements are expected to be key focus areas in future applications of the CSTDM.

Most of the previous locations were thought to be identified as the locations nearest to the screenlines with available counts. However, there were some alternative locations that provided a more accurate representation of the flows identified in the screenline but did not have available hourly Caltrans Vehicle Counts. For these locations, AADT from the Caltrans Count Book and time of day distributions from nearby counts were used. Appendix A shows the location of the screenlines.

As a result, direct comparisons with the validation performance between CSTDM09 and CSTDM Version 2.0 are not always applicable. Appendix B contains a table describing which stations/locations were associated with the specific screenlines.

Roadway Validation Results

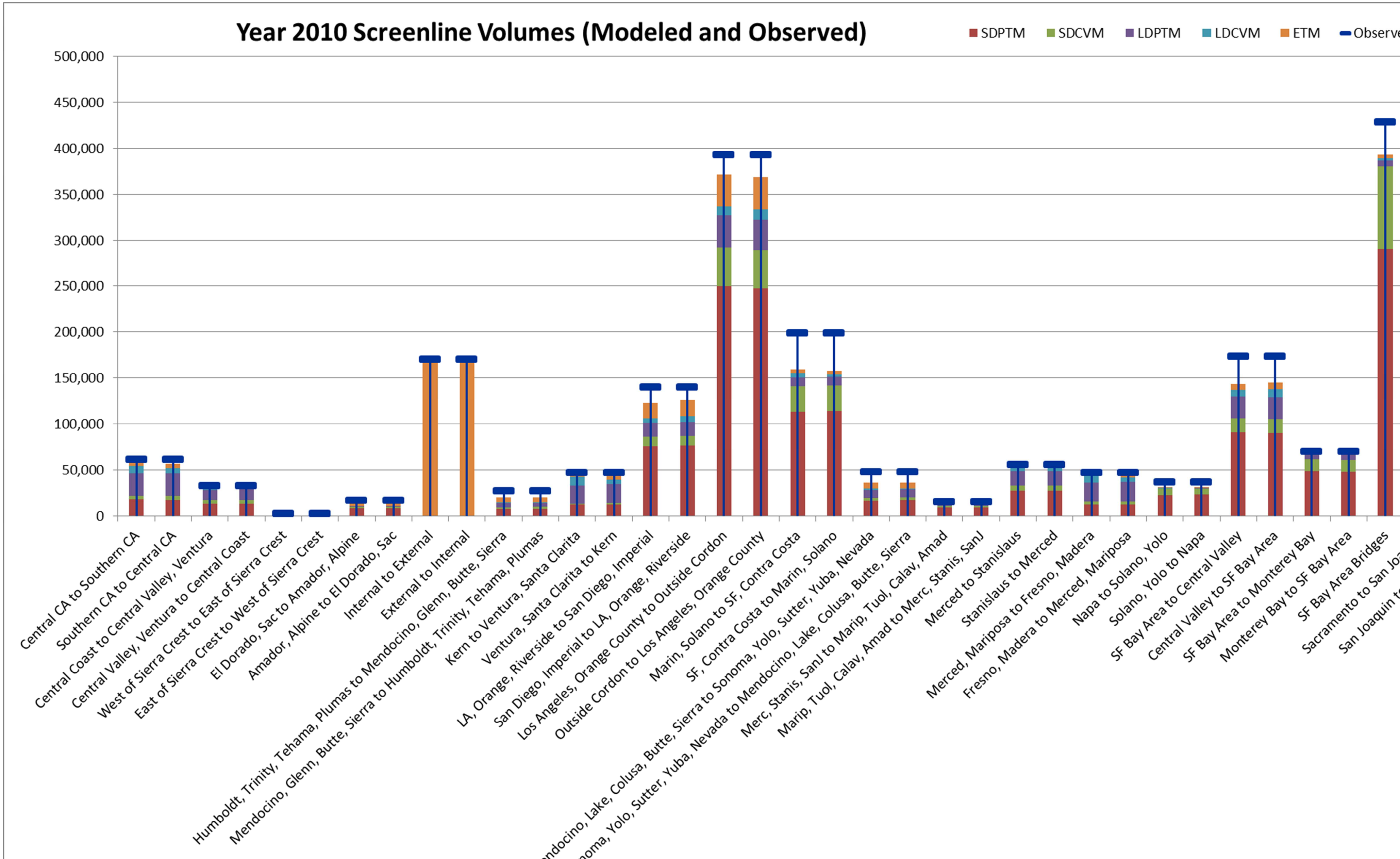
Table 4.6 gives the summary of modeled to observed daily directional vehicle flows for each screenline, for the Year 2010. Figure 4.8 compares the contributed volume from each of the five models and observed volume graphically for each screenline. Screenline locations can be found in Appendix A.

Table 4.6 Total Daily Directional Differences at Screenlines

Screenline	Modeled Volume	Observed Volume	Numeric Diff	Percent Difference
Central Southern California	63,400	61,300	-1,600	-3%
Southern to Central California	60,400	61,300	-4,500	-7%
Central Coast to Central Valley, Ventura	32,100	32,400	-1,900	-6%
Central Valley, Ventura to Central Coast	33,700	32,400	-300	-1%
West of Sierra Crest to East of Sierra Crest	6,500	2,800	3,300	118%
East of Sierra Crest to West of Sierra Crest	6,300	2,800	3,100	111%
El Dorado, Sacramento to Amador, Alpine	15,900	16,700	-2,900	-17%
Amador, Alpine to El Dorado, Sacramento	15,800	16,700	-2,900	-17%
Internal to External	170,900	170,000	3,100	2%
External to Internal	170,600	170,000	2,400	1%
Humboldt, Trinity, Tehama, Plumas to Mendocino, Glenn, Butte, Sierra	21,800	27,400	-6,900	-25%
Mendocino, Glenn, Butte, Sierra to Humboldt, Trinity, Tehama, Plumas	21,800	27,400	-7,100	-26%
Kern to Ventura, Santa Clarita	48,600	47,000	-1,100	-2%
Ventura, Santa Clarita to Kern	46,200	47,000	-3,800	-8%
Los Angeles, Orange, Riverside to San Diego, Imperial	128,300	140,000	-16,800	-12%
San Diego, Imperial to Los Angeles, Orange, Riverside	131,300	140,000	-14,200	-10%
Los Angeles, Orange County to Outside Cordon	392,400	392,500	-20,900	-5%
Outside Cordon to Los Angeles, Orange County	389,400	392,500	-24,300	-6%
Marin, Solano to San Francisco, Contra Costa	166,600	198,800	-39,200	-20%
San Francisco, Contra Costa to Marin, Solano	164,900	198,800	-40,900	-21%
Mendocino, Lake, Colusa, Butte, Sierra to Sonoma, Yolo, Sutter, Yuba, Nevada	38,700	47,400	-11,400	-24%
Sonoma, Yolo, Sutter, Yuba, Nevada to Mendocino, Lake, Colusa, Butte, Sierra	39,200	47,400	-11,000	-23%
Merced, Stanislaus, San Joaquin to Mariposa, Tuolumne, Calaveras, Amador	15,000	15,100	-1,600	-11%
Mariposa, Tuolumne, Calaveras, Amador to Merced, Stanislaus, San Joaquin	14,700	15,100	-1,800	-12%
Merced to Stanislaus	59,600	55,300	900	2%
Stanislaus to Merced	60,900	55,300	2,400	4%
Merced, Mariposa to Fresno, Madera	51,200	47,000	400	1%
Fresno, Madera to Merced, Mariposa	49,100	47,000	-1,800	-4%
Napa to Solano, Yolo	33,600	36,900	-5,900	-16%

Screenline	Modeled Volume	Observed Volume	Numeric Diff	Percent Difference
Solano, Yolo to Napa	33,700	36,900	-5,800	-16%
San Francisco Bay Area to Central Valley	158,200	173,200	-29,400	-17%
Central Valley to San Francisco Bay Area	158,400	173,200	-28,200	-16%
San Francisco Bay Area to Monterey Bay	68,900	69,600	1,500	2%
Monterey Bay to San Francisco Bay Area	67,100	69,600	-400	-1%
San Francisco Bay Area Bridges	398,300	428,300	-35,500	-8%
Sacramento to San Joaquin	56,900	56,700	-3,300	-6%
San Joaquin to Sacramento	56,100	56,700	-4,700	-8%
San Diego to Imperial	7,400	6,300	1,400	22%
Imperial to San Diego	7,600	6,300	1,500	24%
San Joaquin to Stanislaus	91,500	101,500	-16,300	-16%
Stanislaus to San Joaquin	89,800	101,500	-18,200	-18%
Siskiyou, Modoc to Trinity, Shasta, Lassen	5,100	5,100	-100	-2%
Trinity, Shasta, Lassen to Siskiyou, Modoc	5,000	5,100	-200	-4%
Tehama, Shasta to Lassen, Plumas	400	1,300	-800	-62%
Lassen, Plumas to Tehama, Shasta	500	1,300	-800	-62%
Trinity, Mendocino to Glen, Tehama, Shasta	6,300	4,700	900	19%
Glen, Tehama, Shasta to Trinity, Mendocino	6,400	4,300	1,500	35%
Ventura to Santa Clarita	9,600	10,600	-2,200	-21%
Santa Clarita to Ventura	9,600	10,600	-2,300	-22%
Other to Other	61,900	74,300	-16,100	-22%
All screenline volumes combined	**3,747,600**	**3,941,400**	**-364,700**	**-9%**
Without "Other to Other"	**3,685,700**	**3,867,100**	**-348,600**	**-9%**

Figure 4.8 Year 2010 screenline volumes by CSTDM model, compared to Observed



Figures 4.9 and 4.10 shows the year 2010 validation results for vehicle flows, compared to the guidelines for urban travel model screenline performance set out in the NCHRP 255 report (Highway Traffic Data for Urbanized Area Project Planning and Design, NCHRP Report 255, TRB, 1982). The NCHRP 255 guideline figure is applied to screenline volumes up to 200,000 vehicles per day. For the CSTDM validation, it has been extrapolated out to volumes up to 500,000 vehicles per day, to cover the range of volumes represented in the CSTDM screenlines. The results from Figure 4.10 show that model results do not meet the NCHRP 255 standards for every screenline; only one (Marin/Solano to San Francisco/Contra Costa Counties) lies outside the standard but is very close to meeting the guideline.

Figure 4.9 Screenlines: Year 2010 volumes versus NCHRP 255 standard

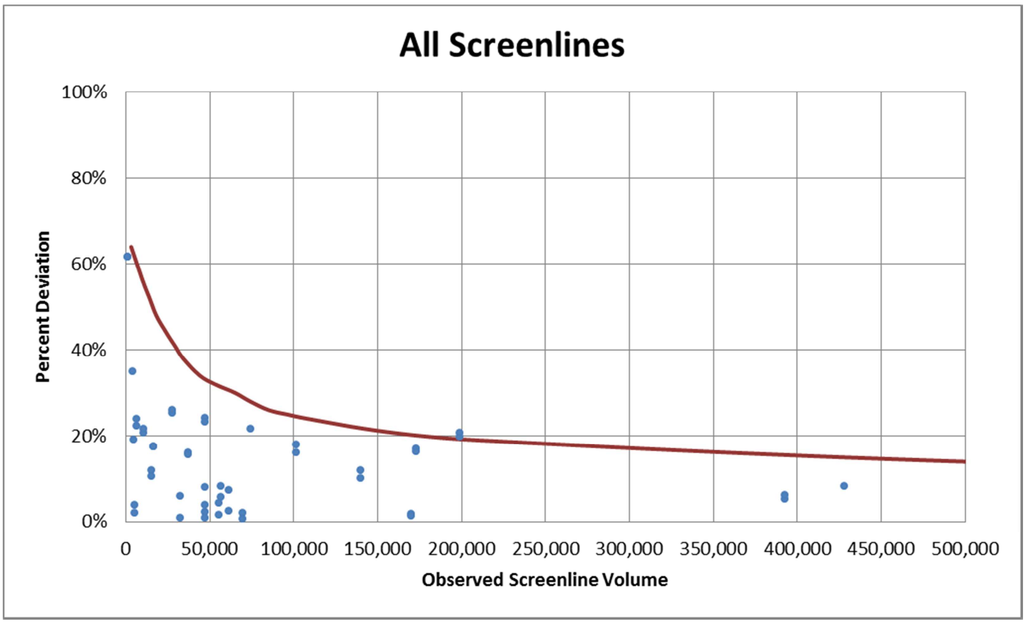


Figure 4.10 Individual Count Stations: Year 2010 volumes versus NCHRP 255 standard

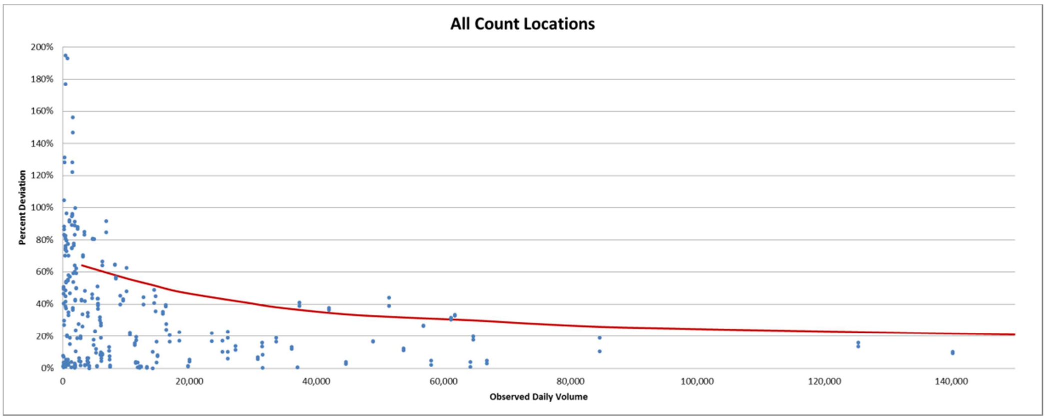
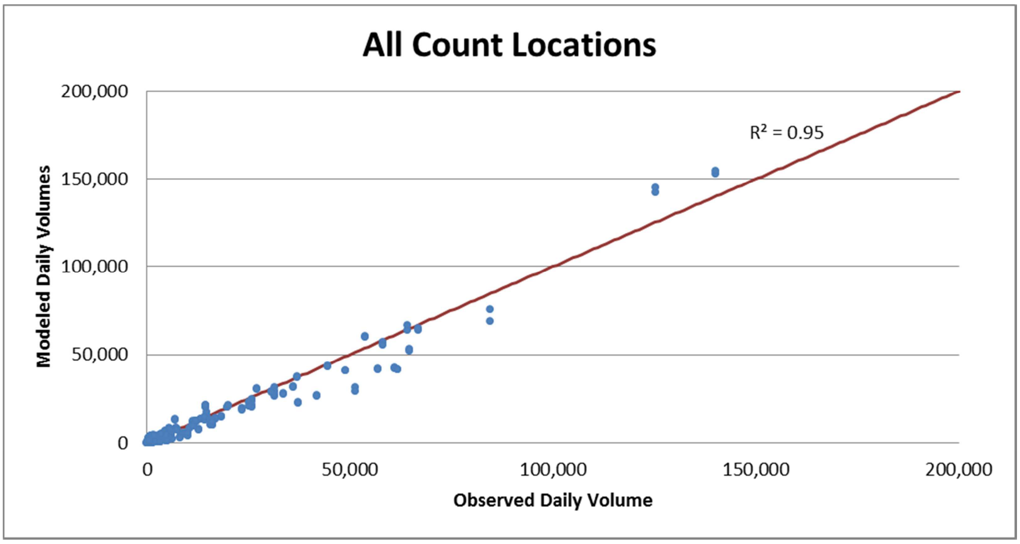


Figure 4.11 shows the 2010 validation results for all of the individual count locations, by direction. The model volumes are quite close to the 45 degree line shown (where model and observed are equal). The R^2 is 0.95, which is quite high.

Figure 4.11 Individual Count Stations: Model Volumes versus Observed



Calculating RMSEs for various geographic regions and facility types provides a good representation of the error at each individual location within those aggregations. Tables 4.7 and 4.8 provide the percent error and percent RMSE for facility types and by Caltrans District, respectively. Figure 4.12 shows the Percent RMSE against daily volume group. While not all locations and aggregations meet the target, the ones that show more than the desired error are still close to the recommend values.

Table 4.7 Percent Error and RMSE by Facility Type

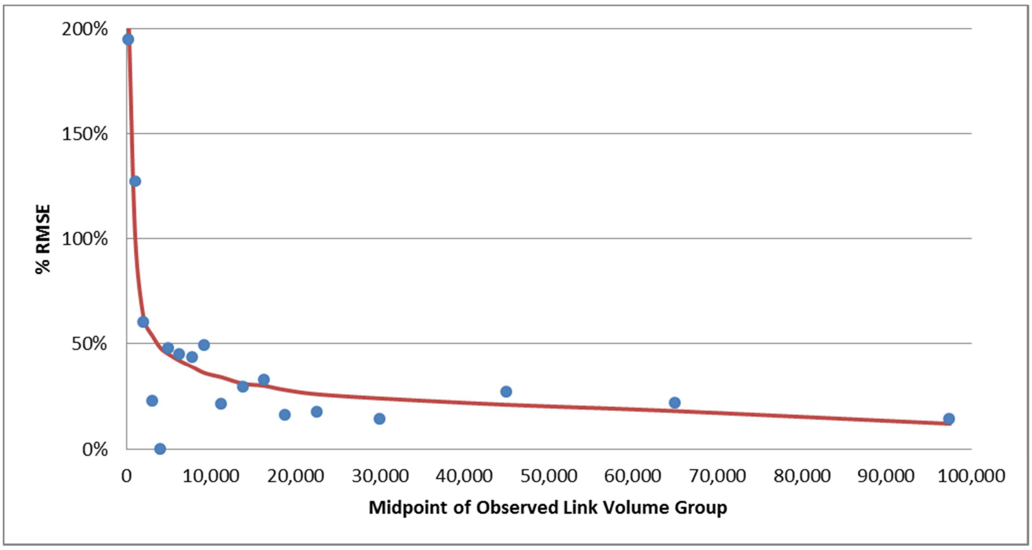
Facility Type	Observed Links Counts	Estimated Link Volumes	Relative Error (E-O)/O	% RMSE	Target % RMSE[1]
Freeway	3,157,700	2,874,300	-9%	26%	24%
Expressway	591,800	516,000	-13%	50%	48%
Arterials and Collectors	176,300	186,500	4%	48%	62%
Total	**3,925,800**	**3,576,700**	**-9%**	**37%**	**34%**

Table 4.8 Percent Error and RMSE by Caltrans District

Caltrans District	Observed Links Counts	Estimated Link Volumes	Relative Error (E-O)/O	% RMSE	Target % RMSE
Northwest Coastal Region	14,100	9,200	-35%	46%	62%
North/Northeast	80,600	75,200	-7%	65%	100%
SACOG	351,300	297,200	-15%	56%	39%
Bay Area	1,039,500	879,100	-15%	34%	24%
North San Joaquin Valley	632,500	580,800	-8%	26%	24%
South San Joaquin Valley	281,000	278,900	1%	32%	36%
Sierras	11,500	13,300	16%	33%	200%
Central Coast	171,700	159,700	-7%	30%	39%
Los Angeles	621,300	617,100	1%	16%	21%
Orange County	129,400	105,200	-19%	26%	21%
San Bernardino/Riverside	284,300	238,700	-16%	36%	30%
San Diego/Imperial County	324,000	322,300	1%	10%	34%
Statewide	**3,941,200**	**3,576,700**	**-9%**	**37%**	**34%**

[1] While recommended %RMSE is available by volume group, no guidance exists by other groupings such as facility or area type. Therefore, a target %RMSE is approximated based on the total observed volume divided by the number of locations to get an average volume for the group, which is related back to the recommended %RMSE by volume group.

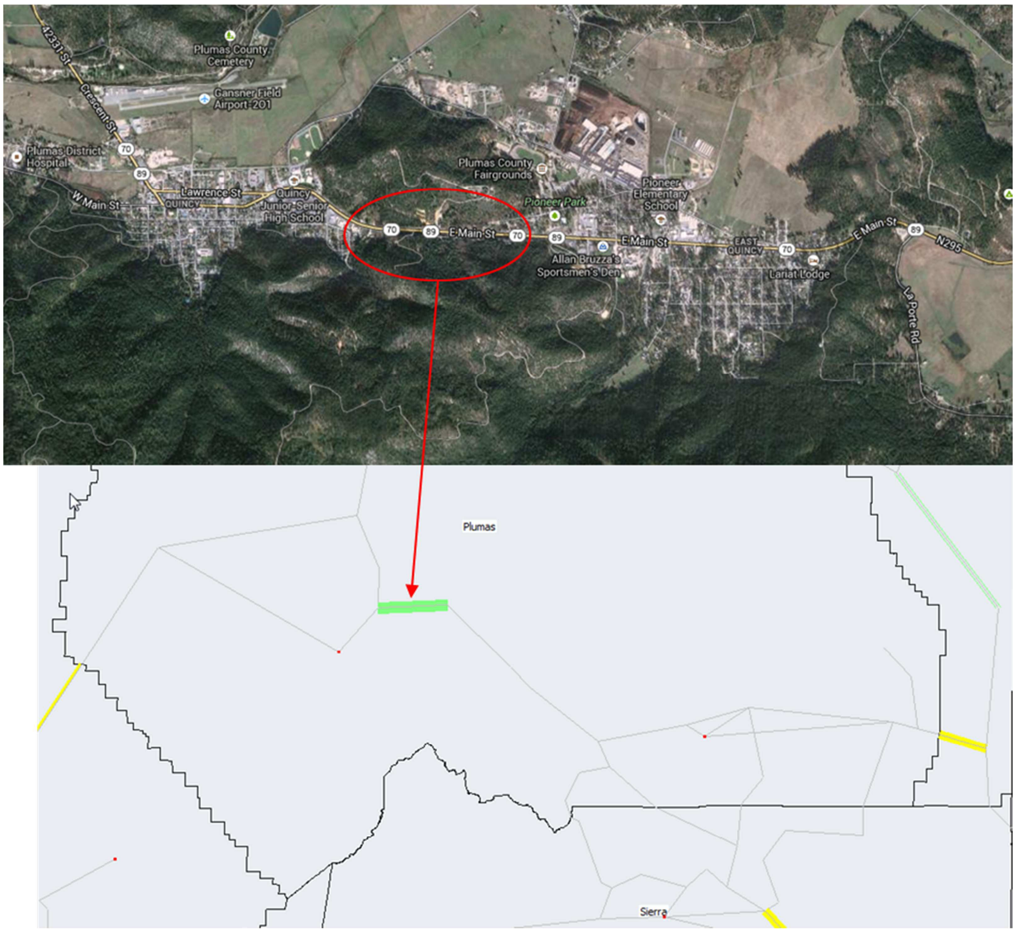
Figure 4.12 Percent RMSE for Daily Assignments



In general, the 2010 model under-estimates 2010 observed traffic flows. Although there may be several reasons for this, two factors relevant to the CSTDM application need to be noted:

1. CSTDM does not model all trips in California – exceptions include visitors to California.
2. Trips loading onto the network are simplified, compared to actual conditions. In rural areas with large zones and low population, centroid connector locations near counts can over- or under-estimate volume on particular segments. For example, as shown in Figure 4.13, the count location is located in between two developed areas which are represented by one TAZ. The model is not capturing the cross-traffic between the two areas that would be included in the counts.

Figure 4.13 Example Difference between Model and Count Volume



Time of Day

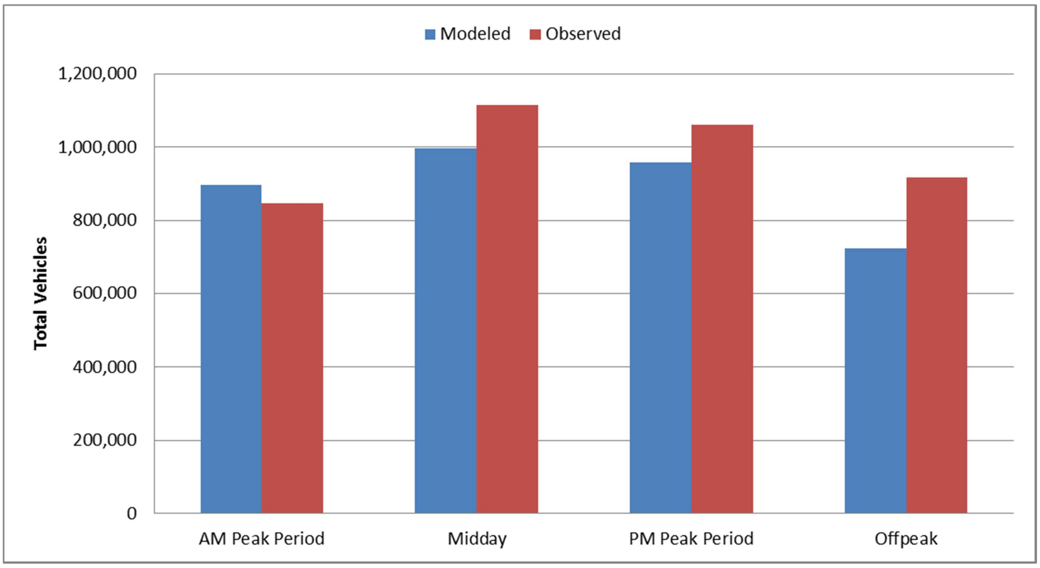
One feature that should be mentioned is that the CSTDM explicitly forecasts travel by time of day (AM peak, midday, PM peak, off-peak). However, the CSTDM models a large number of vehicle trips that are long in terms of trip length (for both distance and time). These longer trips present significant challenges for accurate comparison of model and observed flows by time periods, for two reasons:

1. In the current application of the CSTDM a trip has to be assigned to one of the four time periods; and
2. The static assignment process implicitly assumes that, for each vehicle trip in the trip list, the trip simultaneously travels on every road link between the origin zone and the destination zone.

For example, a vehicle trip between San Francisco and Los Angeles starting at 9AM may take seven hours, and travel in three different model time periods (AM, midday, PM). In the modeling process, it has to be allocated to only one of these time periods, and is counted on every link it uses between San Francisco and Los Angeles in that time period.

Figure 4.14 compares the model time of day distribution for vehicle flows with observed data. Given the challenges, the time period distribution is still fairly reasonable.

Figure 4.14 Total Screenline Crossings by Time Period



4.4 TRUCK TRAFFIC

After assembling available truck data, it was acknowledged that there was not sufficient reliable information on truck traffic to conduct a true validation effort.

Given multiple data sources, instances of multiple counts available at single locations provided ranges of estimated truck traffic. These ranges of truck traffic were compared to modeled truck data for reasonableness checks. As an example, if the range of truck traffic at a particular location was 5 percent to 15 percent, trucks comprising 75 percent of that modeled total daily traffic would indicate a potential inaccuracy in the model.

Table 4.9 provides a comparison of the range of observed volumes by data source. While it seems the model may be overestimating total trucks, there is not enough information to justify any changes in the models. Furthermore, the LDCVM was expected to be informed by the California Statewide Freight Forecasting Model (CSFFM) resulting in a significant change to truck traffic in a subsequent model update.

Table 4.9 Modeled Truck Traffic

Truck Count Data Source	Locations Within Expected Range	Total Number of Locations	Share of Count Locations within Expected Range	Observed Volume (Low)	Observed Volume (High)	Modeled
SCAG	7	25	28%	96,500	123,600	182,600
Caltrans Vehicle Class Counts	13	25	52%	12,200	25,700	33,600
CaltransCountBook (Higher Confidence Locations)	4	11	36%	16,000	17,200	19,500
CaltransCountBook (Lower Confidence Locations)	29	75	39%	213,300	253,300	350,700
All Locations	66	161	41%	338,000	419,800	586,400

4.5 Air Travel

The LDPTM component of the CSTDM forecasts air travel made by California residents. Observed data for year 2010 air flows for main corridors has been tabulated from air passenger travel data. These flows are compared with model results in Table 4.10 below.

Table 4.10 2010 Daily Air Travel Validation Results

Air Corridor	2010 Daily Model Flows	2010 Daily Observed Flows	Percent Difference
Los Angeles Basin - San Francisco Bay Area	21,350	20,130	-6%
Los Angeles Basin - Sacramento	5,360	4,400	-18%
San Francisco Bay Area - San Diego	6,620	5,770	-13%
San Diego - Sacramento	1,690	1,760	4%
Los Angeles Basin - San Diego	90	150	67%
Other	1,200	970	-19%
Total	**36,310**	33,180	-9%

The observed flows include data on:

- Flights made by California residents for intrastate travel;
- Flights made by California residents on connecting flights as part of out-of-state travel; and
- Flights made by out-of-state persons.

The model only considers the first of these categories, and so it should generally under predict air flows. Given this, Table 4.10 shows a reasonable fit between observed and model air flows.

4.6 Transit Ridership

Accurately forecasted transit ridership was a desirable, but not a main objective of the CSTDM Update project. Most riders use transit within one urban area, and regional models can better predict their behavior and maintain the models to do so. However, the CSTDM does need to reflect realistic mode shares. Observed data on transit systems were collected and compared to modeled trips to evaluate the CSTDM Version 2.0 performance.

Local Bus Ridership

Local bus was synthetically represented and specific routes were not coded into the CSTDM; therefore it was not possible to assign transit trips to specific local bus routes[2]. The FTA NTD observed boardings by operator were compared to modeled transit trips within the transit catchment areas specified in the local bus inputs, as shown in Figure 4.15. Results of this comparison are provided in Table 4.11, by catchment area.

Comparing boardings (unlinked transit trips) to linked transit trips, the expectation was that the CSTDM would be low. That is, a traveler might make two transit boardings to complete one trip. For example a rider could travel from home to work riding a Los Angeles Metro local bus and then transferring to the Red Line. This would be one linked transit trip (from home to work), but includes two boardings. Assuming an average 1.3 boardings per linked transit trip, CSTDM modeled estimate of transit ridership was a little high (18 percent) overall.

[2] Please see documentation on CSTDM transit coding at the Caltrans CSTDM Website: http://www.dot.ca.gov/hq/tsip/otfa/cstdm/documents/tdm/CSTDM09_Local_Transit_Function_Final.pdf, Accessed, April 1, 2014.

Figure 4.15 CSTDM Transit Catchment Areas

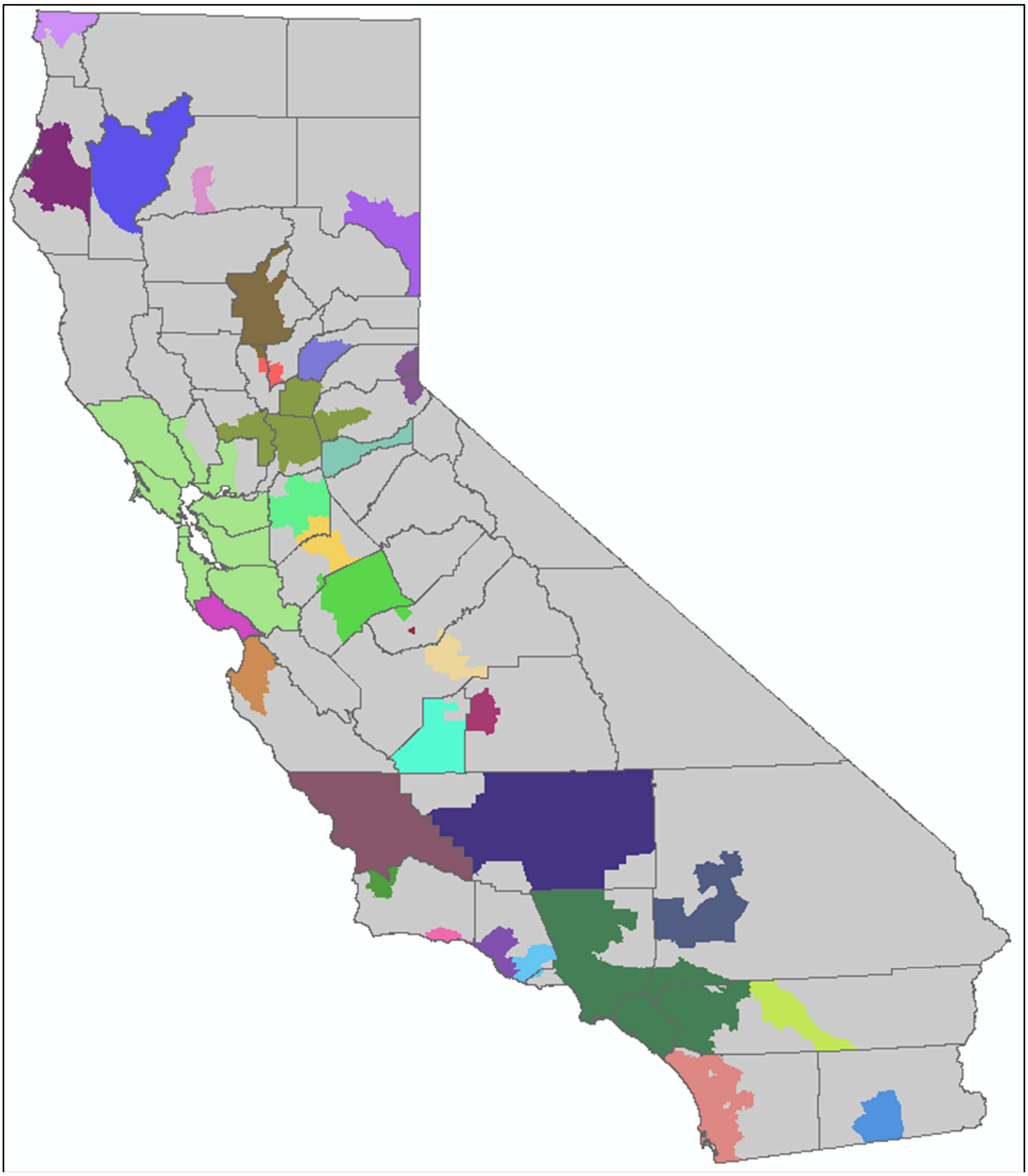


Table 4.11 Comparison

Transit Catchment Areas and Major Rail Operators	Observed Ridership (Unlinked Trips)	Modeled Trips	Percent Difference
Del Norte	0	300	--
Humboldt	0	2,600	--
Lassen	0	300	--
Trinity County	0	100	--
Redding	2,300	3,800	65%
Butte/Chico/Oroville	4,400	6,600	50%
Amador	0	300	--
Nevada County	0	1,300	--
Yuba-Sutter	3,600	4,600	28%
Sacramento Region	138,700	124,000	-11%
San Francisco Bay Area	1,547,000	1,424,600	-8%
San Joaquin	16,300	23,900	47%
Modesto	10,700	17,400	63%
Merced	3,200	7,900	147%
Madera	0	0	--
Fresno	60,600	45,600	-25%
Kings County	2,600	3,700	42%
Visalia	7,100	9,400	32%
Kern County	24,000	29,700	24%
Santa Cruz	19,000	14,200	-25%
Monterey-Salinas	13,000	14,100	8%
San Luis Obispo	5,600	8,200	46%
Santa Barbara County	26,400	19,400	-27%
Santa Maria	3,900	5,300	36%
Western Ventura County	13,400	17,000	27%
Thousand Oaks/Simi Valley	2,400	9,900	313%
Los Angeles	2,200,200	1,924,200	-13%
Victor Valley	4,800	10,000	108%
Palm Springs/Coachella	11,300	15,300	35%
Imperial Valley	2,200	3,800	73%
San Diego	300,400	250,300	-17%
Lake Tahoe Area	0	300	--
Amtrak - Capitol Corridor, San Joaquins, and Pacific Surfliner	8,000	23,600	105%
Amtrak - Others	3,500		
Statewide	**4,434,600**	**4,021,700**	-9%

Rail Ridership

Dedicated railways are explicitly coded in the model, and transit trips can be assigned to these routes. However, without any bus routing available to compete with the rail lines, assigned transit ridership in this framework should be higher than observed because there are no other options available in the assignment. Regardless, the transit trips were assigned to a few key rail lines for reasonableness checks along key corridors with few transit options, for the cleanest comparisons possible.

Tables 4.11 and 4.12 provide comparisons for the Transbay and North Bay-San Francisco movements. Figure 4.16 provides a look at the assigned BART segment loads against observed loads from 2010; while the totals may not match, the travel patterns seem very reasonable.

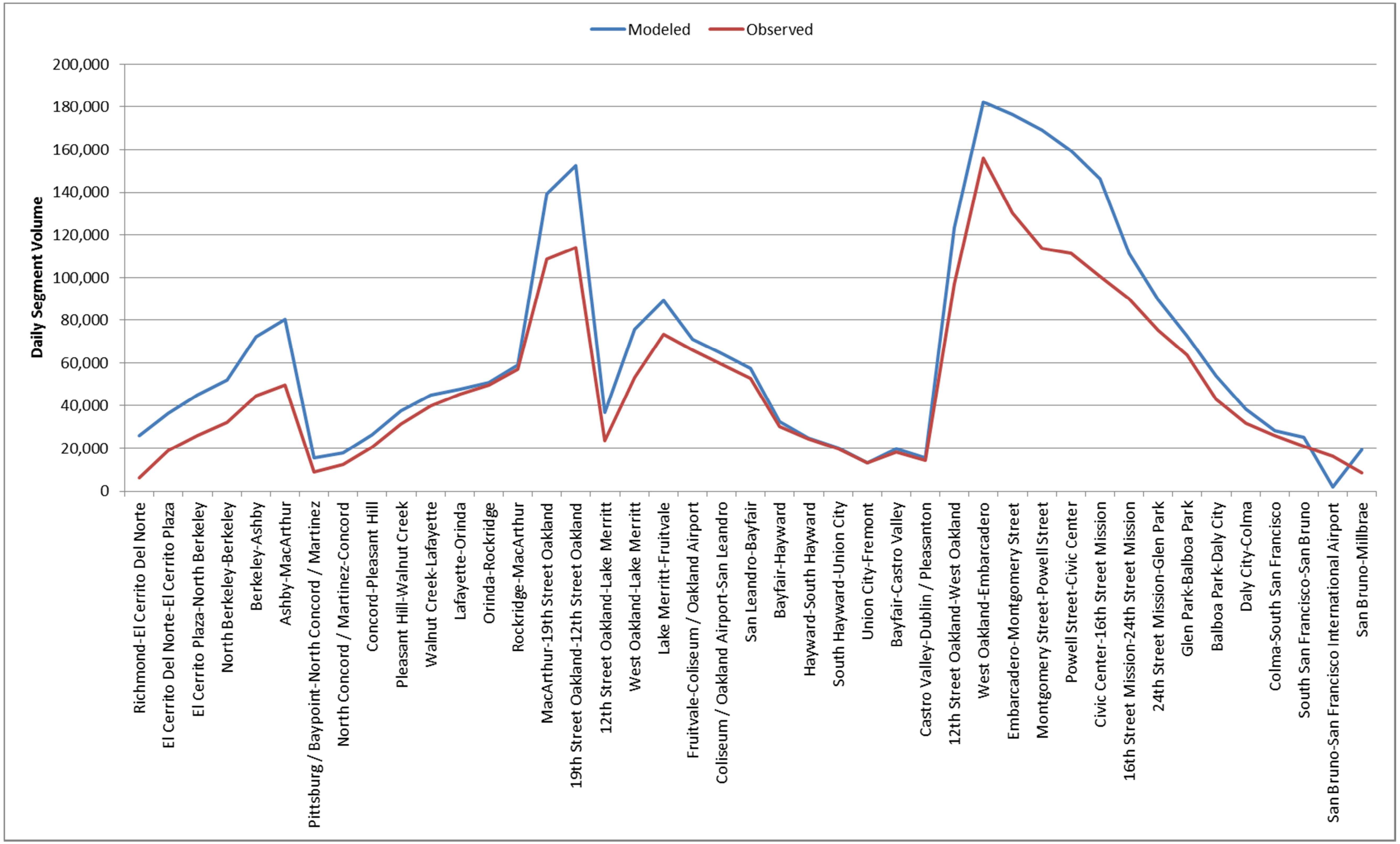
Table 4.12 Transbay Transit Ridership

Transbay Transit Providers	Modeled	Observed	Absolute Difference	Percent Difference
BART	182,296	156,004	26,292	17%
AC Transit (Transbay)	--	14,704	-14,704	-100%
East Bay Ferries	5,957	1,853	4,104	221%
Total	**188,254**	**172,561**	**15,692**	**9%**

Table 4.13 San Francisco-North Bay Trip Ridership

SF/North Bay Transit Providers	Modeled	Observed	Absolute Difference	Percent Difference
Golden Gate Transit (To SF)	--	10,990	-10,990	-100%
Golden Gate Ferry (Larkspur)	6,675	4,817	1,858	39%
Golden Gate Ferry (Sausalito)	3,174	1,630	1,544	95%
Tiburon Ferry	2,613	825	1,788	217%
Total	**12,462**	**18,262**	**-5,800**	**-32%**

Figure 4.16 BART Ridership – Modeled versus Observed Segment Loads



5.0 Year 2000 Backcast

5.1 Vehicle Flows

Table 5.1 gives the summary of modeled to observed daily directional vehicle flows for each screenline, for the year 2000. Figures 5.1 and 5.2 shows the year 2000 validation results for vehicle flows, compared to the guidelines for urban travel model screenline performance set out in the NCHRP 255 report. The results from Figure 5.2 show that model results meet the NCHRP 255 standards for every screenline.

Table 5.1 Total Daily Directional Differences at Screenlines

Screenline	Modeled Volume	Observed Volume	Numeric Diff	Percent Diff
Central CA to Southern CA	49,000	52,600	-3,600	-7%
Southern CA to Central CA	46,800	52,600	-5,800	-11%
Central Coast to Central Valley, Ventura	29,000	29,700	-700	-2%
Central Valley, Ventura to Central Coast	30,200	29,700	500	2%
West of Sierra Crest to East of Sierra Crest	4,700	2,000	2,700	135%
East of Sierra Crest to West of Sierra Crest	4,400	2,000	2,400	120%
El Dorado, Sac to Amador, Alpine	13,200	16,800	-3,600	-21%
Amador, Alpine to El Dorado, Sac	12,900	16,800	-3,900	-23%
Internal to External	194,700	194,200	500	0%
External to Internal	196,600	194,200	2,400	1%
Humboldt, Trinity, Tehama, Plumas to Mendocino, Glenn, Butte, Sierra	19,900	26,300	-6,400	-24%
Mendocino, Glenn, Butte, Sierra to Humboldt, Trinity, Tehama, Plumas	20,100	26,300	-6,200	-24%
Kern to Ventura, Santa Clarita	41,000	38,700	2,300	6%
Ventura, Santa Clarita to Kern	38,500	38,700	-200	-1%
LA, Orange, Riverside to San Diego, Imperial	112,100	116,800	-4,700	-4%
San Diego, Imperial to LA, Orange, Riverside	113,400	116,800	-3,400	-3%
Los Angeles, Orange County to Outside Cordon	351,900	364,600	-12,700	-3%
Outside Cordon to Los Angeles, Orange County	345,000	364,600	-19,600	-5%
Marin, Solano to SF, Contra Costa	201,000	201,700	-700	0%
SF, Contra Costa to Marin, Solano	199,800	201,700	-1,900	-1%
Mendocino, Lake, Colusa, Butte, Sierra to Sonoma, Yolo, Sutter, Yuba, Nevada	34,000	44,800	-10,800	-24%
Sonoma, Yolo, Sutter, Yuba, Nevada to Mendocino, Lake, Colusa, Butte, Sierra	34,600	44,800	-10,200	-23%

Screenline	Modeled Volume	Observed Volume	Numeric Diff	Percent Diff
Merc, Stanis, SanJ to Marip, Tuol, Calav, Amad	12,000	12,900	-900	-7%
Marip, Tuol, Calav, Amad to Merc, Stanis, SanJ	12,100	12,900	-800	-6%
Merced to Stanislaus	48,000	52,600	-4,600	-9%
Stanislaus to Merced	49,500	52,600	-3,100	-6%
Merced, Mariposa to Fresno, Madera	42,400	41,300	1,100	3%
Fresno, Madera to Merced, Mariposa	41,100	41,300	-200	0%
Napa to Solano, Yolo	30,700	35,600	-4,900	-14%
Solano, Yolo to Napa	30,900	35,600	-4,700	-13%
SF Bay Area to Central Valley	143,200	166,200	-23,000	-14%
Central Valley to SF Bay Area	144,600	166,200	-21,600	-13%
SF Bay Area to Monterey Bay	66,200	74,200	-8,000	-11%
Monterey Bay to SF Bay Area	64,500	74,200	-9,700	-13%
SF Bay Area Bridges	493,300	489,400	3,900	1%
Sacramento to San Joaquin	47,500	50,700	-3,200	-6%
San Joaquin to Sacramento	46,700	50,700	-4,000	-8%
San Diego to Imperial	8,700	5,700	3,000	53%
Imperial to San Diego	8,900	5,700	3,200	56%
San Joaquin to Stanislaus	74,600	83,800	-9,200	-11%
Stanislaus to San Joaquin	73,300	83,800	-10,500	-13%
Siskiyou, Modoc to Trin, Shas, Lass	5,100	5,400	-300	-6%
Trin, Shas, Lass to Siskiyou, Modoc	4,900	5,400	-500	-9%
Tehama, Shasta to Lassen, Plumas	500	1,400	-900	-64%
Lassen, Plumas to Tehama, Shasta	500	1,400	-900	-64%
Trinity, Mendocino to Glen, Teha, Shasta	5,800	4,700	1,100	23%
Glen, Teha, Shasta to Trinity, Mendocino	5,700	3,900	1,800	46%
Ventura to Santa Clarita	7,500	8,900	-1,400	-16%
Santa Clarita to Ventura	7,500	8,900	-1,400	-16%
Other to Other	55,700	65,200	-9,500	-15%
All screenline volumes combined	**3,624,200**	**3,817,000**	**-192,800**	**-5%**
Without "Other to Other"	**3,568,500**	**3,751,800**	**-183,300**	**-5%**

Figure 5.1 Screenlines: Year 2000 Volumes versus NCHRP 255 Standard

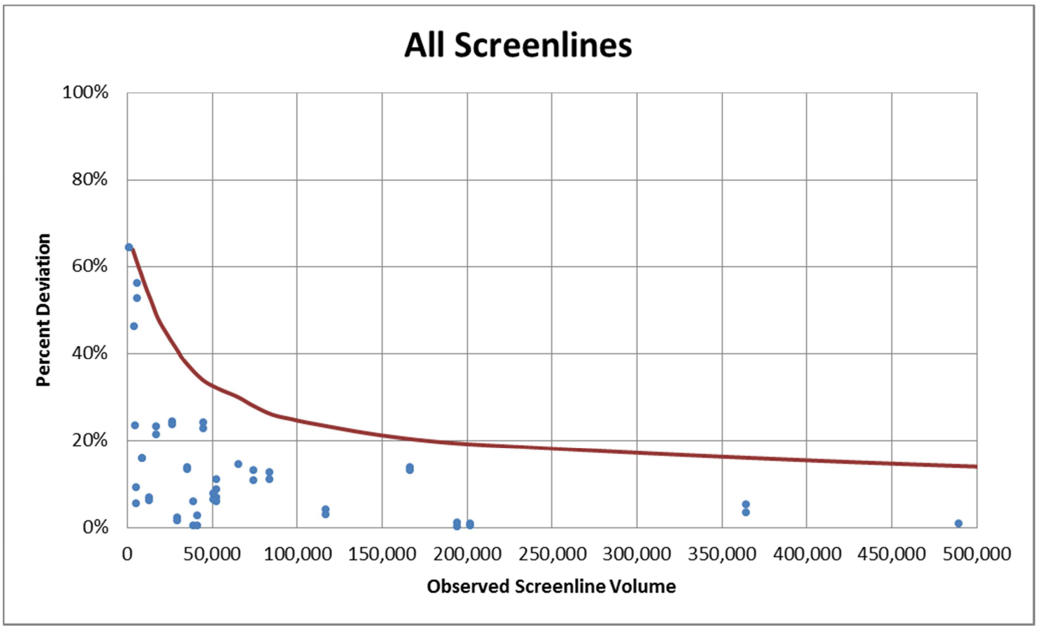


Figure 5.2 Individual Count Stations: Year 2000 Volumes versus NCHRP 255 Standard

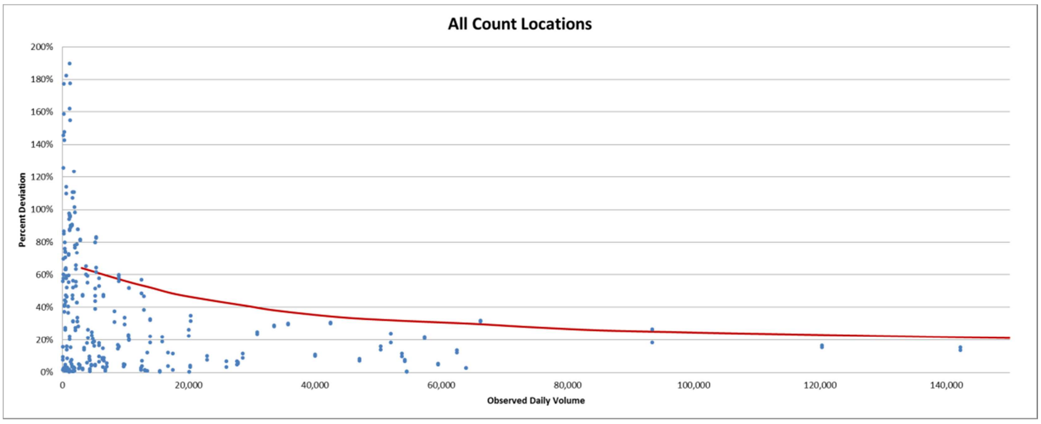
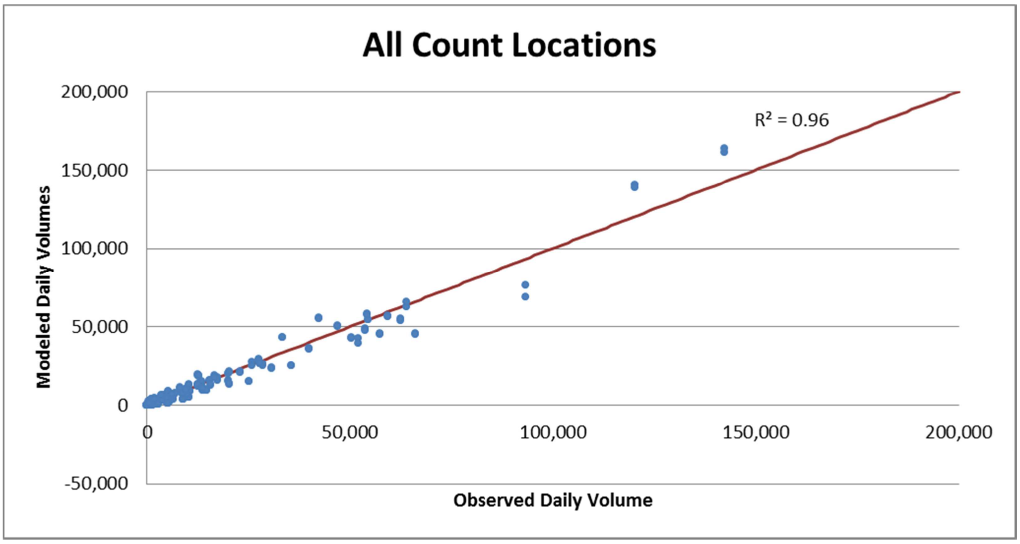


Figure 5.3 shows the 2000 validation results for all of the individual count locations. The model volumes are quite close to the 45 degree line shown (where model and observed are equal). The R^2 is 0.96, which is quite high, similar to results of the Year 2010 validation.

Figure 5.3 Individual Count Stations: Model Volumes versus Observed



Calculating RMSEs for various geographic regions and facility types provides a good representation of the error at each individual location within those aggregations. Tables 5.2 and 5.3 provide the percent error and percent RMSE for facility types and by Caltrans District, respectively. Figure 5.4 shows the %RMSE against daily volume group. While not all locations and aggregations meet the target, the ones that show more than the desired error are still close to the recommend values.

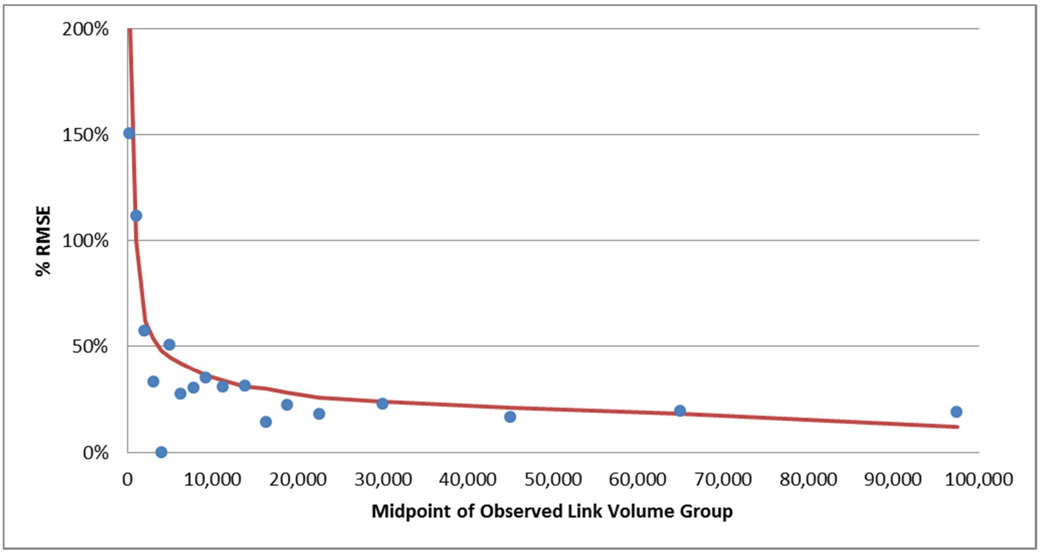
Table 5.2 Percent Error and RMSE by Facility Type

Facility Type	Observed Links Counts	Estimated Link Volumes	Relative Error (E-O)/O	% RMSE
Freeway	3,044,800	2,928,000	-4%	25%
Expressway	548,800	477,400	-13%	51%
Arterials and Collectors	188,100	193,300	3%	34%
Total	**3,781,700**	**3,598,800**	**-5%**	**36%**

Table 5.3 Percent Error and RMSE by Caltrans District

Caltrans District	Observed Links Counts	Estimated Link Volumes	Relative Error (E-O)/O	% RMSE
Northwest Coastal Region	13,600	8,500	-38%	50%
North/Northeast	82,000	78,400	-4%	70%
SACOG	332,600	299,100	-10%	37%
Bay Area	1,100,100	1,051,000	-4%	29%
North San Joaquin Valley	579,300	523,800	-10%	27%
South San Joaquin Valley	232,300	244,500	5%	37%
Sierras	11,700	10,900	-7%	60%
Central Coast	172,300	150,500	-13%	27%
Los Angeles	592,800	584,900	-1%	25%
Orange County	125,000	109,000	-13%	18%
San Bernardino/Riverside	242,400	214,800	-11%	28%
San Diego/Imperial County	333,100	348,700	5%	12%
Statewide	**3,817,200**	**3,624,100**	**-5%**	**36%**

Figure 5.4 Percent RMSE for Daily Assignments



6.0 Sensitivity Tests

6.1 INTRODUCTION

Sensitivity tests were conducted to evaluate the CSTDM SDPTM and LDPTM performance. The SDCVM, LDCVM and ETM components were not thus evaluated.

One attractive feature of the CSTDM is the feedback processes to trip generation and mode choice, which more accurately represents induced or suppressed travel effects. Therefore, each of the sensitivity alternatives was each run through three full model iterations to minimize the possibility of under- or over-stating the effects of the tested scenarios.

Experimental sensitivity tests, where a single factor or variable is adjusted higher or lower from its baseline value, were run to determine the corresponding changes in model output variables. Results to each test have been reported for metrics where change was expected and, in some cases, where no change was expected. Those metrics variously included the following:

- Total person trips by mode,
- Total person trips by purpose,
- Household auto ownership, and
- Total vehicle miles traveled (VMT).

The project team discussed a variety of possible sensitivity tests, along with reviewing recommended tests in the 2010 California Regional Transportation Plan (RTP) Guidelines. The project team determined most of the model sensitivity tests in the RTP guidelines could be grouped into three categories: change in land use, change in networks, and change in costs. The Year 2000 backcast scenario evaluated changes in each of these categories and had the added bonus of being able to evaluate the quantity of change by comparing to observed data. Additional sensitivity tests, described in this section, evaluated changes individually to costs (auto operating costs) and the transportation system (transit service).

6.2 INCREASED AUTO OPERATING COSTS

The link between fuel costs and travel behavior is of key interest to many planning agencies, given uncertainties over the future gasoline (and other transportation fuel) costs. Auto operating costs, which include fuel and some maintenance expenses, is a model input with direct impacts on mode choice and other trip-making behaviors.

The base scenario assumed an auto operating cost of 23 cents per mile in Year 2010 dollars, and the test scenario doubled the auto operating costs (to 46 cents per mile).

SDPTM Response to Auto Operating Cost Change

Auto Ownership

An auto ownership model, which feeds into the final trip generation model, is part of the SDPTM. The input for the model is the synthesized population, and the outputs include vehicle ownership and the auto availability levels for each household. The expected result would be a shift for households to have fewer vehicles.

As shown in Table 6.1, the number of zero-vehicle households increased by 11 percent, and resulted in a modest one percent decrease in total vehicles. Geographically, the smallest changes in auto ownership occur were in rural areas, where there are fewer alternatives to driving.

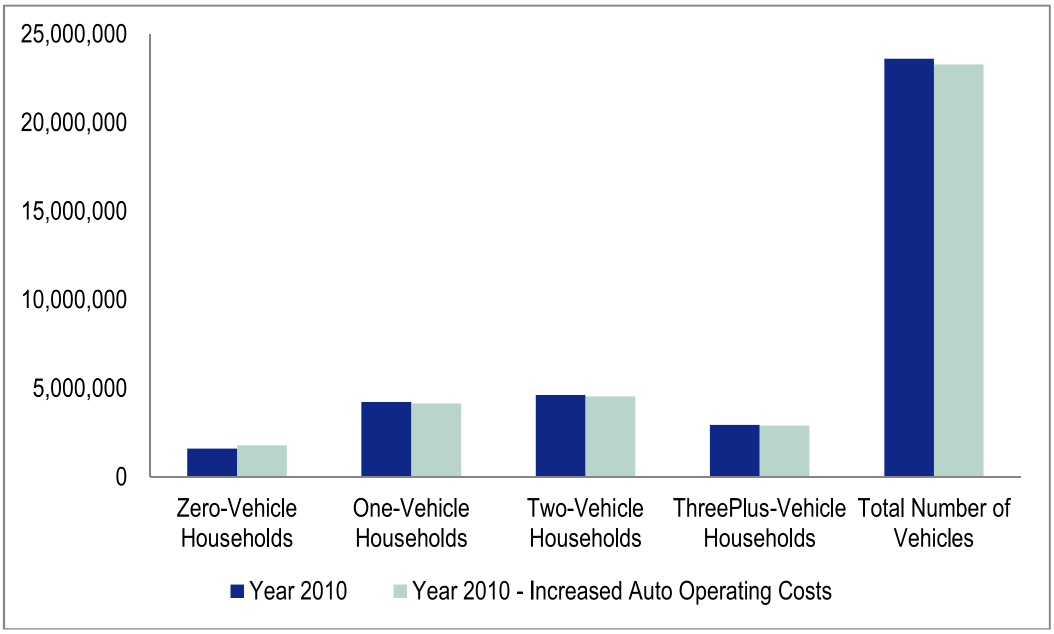
Table 6.1 Auto Ownership Shares by Region – Increased Auto Operating Costs Scenario

Geographic Area	Number of Households[3] by Vehicle Ownership				Total Vehicles
	0 Vehicles	1 Vehicles	2 Vehicles	3+ Vehicles	
Far North	5%	-2%	-1%	2%	**0%**
Sacramento Region including Lake Tahoe	8%	-1%	-1%	0%	**-1%**
San Francisco Bay Area	3%	-3%	-2%	-1%	**-2%**
San Joaquin Valley	4%	-1%	-1%	0%	**-1%**
Western Sierra Nevada	3%	-1%	-2%	2%	**0%**
AMBAG Region	7%	-2%	-1%	0%	**-1%**
San Luis Obispo and Santa Barabara	5%	-2%	-1%	0%	**-1%**
SCAG Region	13%	-2%	-2%	-2%	**-2%**

[3] Note that the synthetic population counts group quarters populations as one-person households. The numbers of households in this instance include group quarters "households."

Geographic Area	Number of Households[3] by Vehicle Ownership				Total Vehicles
	0 Vehicles	1 Vehicles	2 Vehicles	3+ Vehicles	
San Deigo	10%	-2%	-1%	-1%	**-1%**
Statewide	11%	-2%	-1%	-1%	**-1%**

Figure 6.1 Number of Households by Auto Ownership – Increased Auto Operating Costs Scenario



Trips by Mode

Table 6.2 shows essentially no change in the total number of trips, despite the increase in auto operating costs (revealing an inelasticity of the trip generation model); however there were mode shifts. Selected California regions are shown in Table 6.2 to see if mode shifts varied between urban areas with greater availability of transit options (such as the San Francisco Bay Area or Los Angeles Region) versus the more auto-oriented San Joaquin Valley.

The auto operating costs test showed similar results across the state, with decreases in single-occupancy vehicle (SOV) trips and increases in transit and non-motorized trips, but the changes were more pronounced in the San Francisco Bay Area and Los Angeles Regions and less pronounced in the San Joaquin Valley.

Table 6.2 SDPTM Person Trips by Mode – Increased Auto Operating Costs Scenario

Geographic Area	Scenario	SOV	HOV 2+	HOV 3+	Transit	Non-motorized	Total Trips
San Francisco Bay Area	2010 Base Run	10,193,500	7,835,500	5,292,100	1,436,400	2,420,800	27,178,300
	2010 Testing Scenario	9,758,000	7,788,400	5,238,800	1,560,000	2,746,300	27,091,500
	Percent Change	-4%	-1%	-1%	9%	13%	0%
SCAG Region	2010 Base Run	24,997,500	20,073,600	14,797,100	1,946,400	5,427,000	67,241,600
	2010 Testing Scenario	23,960,400	19,949,000	14,642,500	2,270,200	6,239,000	67,061,100
	Percent Change	-4%	-1%	-1%	17%	15%	0%
San Joaquin Valley	2010 Base Run	4,892,200	4,227,400	3,472,400	137,500	1,253,400	13,982,900
	2010 Testing Scenario	4,765,300	4,215,900	3,457,200	156,500	1,409,200	14,004,100
	Percent Change	-3%	0%	0%	14%	12%	0%
Rest of State	2010 Base Run	12,017,700	8,764,585	6,078,580	450,008	2,174,250	29,485,123
	2010 Testing Scenario	11,647,000	8,784,200	6,043,800	512,400	2,472,600	29,460,000
	Percent Change	-3%	0%	-1%	14%	14%	0%
Statewide	2010 Base Run	52,100,900	40,901,085	29,640,180	3,970,308	11,275,450	137,887,923
	2010 Testing Scenario	50,130,700	40,737,500	29,382,300	4,499,100	12,867,100	137,616,700
	Percent Change	-4%	0%	-1%	13%	14%	0%

LDPTM Response to Auto Operating Cost Change

For the LDPTM, we would expect similar responses to changes in auto operating costs as found in the SDPTM, such as decreases in auto mode shares. As expected, the results for the LDPTM model were similar to the SDPTM – share of drive trips all declines, while rail and air showed corresponding increases.

Trips by Mode

Table 6.3 shows the changes in number of trips by mode by geographic area for the LDPTM, given the increase in auto operating costs. The increased costs do have an effect on the number of trips, showing an overall six percent decrease in long-distance trips and shift to rail and air modes, as would be expected.

Table 6.3 LDPTM Person Trips by Mode – Increased Auto Operating Costs Scenario

Geographic Area	Scenario	SOV	HOV 2+	HOV 3+	Rail	Air	Total Trips
San Francisco Bay Area	2010 Base Run	14,000	15,200	15,500	500	12,700	57,900
	2010 Testing Scenario	11,700	13,100	13,400	800	13,800	52,800
	Percent Change	-16%	-14%	-14%	60%	9%	-9%
SCAG Region	2010 Base Run	27,500	26,500	28,700	1,100	12,200	96,000
	2010 Testing Scenario	24,900	24,000	26,300	1,800	13,400	90,400
	Percent Change	-9%	-9%	-8%	64%	10%	-6%
San Joaquin Valley	2010 Base Run	11,500	11,700	13,300	700	300	37,500
	2010 Testing Scenario	10,200	11,200	12,400	1,200	400	35,400
	Percent Change	-11%	-4%	-7%	71%	33%	-6%
Rest of State	2010 Base Run	33,700	35,200	32,900	1,500	7,100	110,400
	2010 Testing Scenario	30,700	32,300	30,000	2,300	8,300	103,600
	Percent Change	-9%	-8%	-9%	53%	17%	-6%
Statewide	2010 Base Run	86,700	88,600	90,400	3,800	32,300	301,800
	2010 Testing Scenario	77,500	80,600	82,100	6,100	35,900	282,200
	Percent Change	-11%	-9%	-9%	61%	11%	-6%

Trips by Purpose

Table 6.4 provides the change in trips by purpose for the LDPTM. Percent changes for business/commute trips are shown to be less sensitive to changes in cost than recreation/other trips which, intuitively, makes sense. Work-related trips tend to be considered mandatory, while non-work trips are discretionary. The project team speculates that business/commute travel may have increased due to less overall congestion on the transportation system. In addition, business travel costs are generally not borne out of pocket, but rather by the traveler's employer. However, more analysis of this specific result will be required for a fuller understanding.

Table 6.4 LDPTM Person Trips by Trip Purpose – Increased Auto Operating Costs Scenario

Geographic Area	Scenario	Business/ Commute	Recreation/ Other
San Francisco Bay Area	2010 Base Run	20,400	37,400
	2010 Testing Scenario	21,300	31,700
	Percent Change	4%	-15%
SCAG Region	2010 Base Run	32,000	64,000
	2010 Testing Scenario	33,600	56,700
	Percent Change	5%	-11%
San Joaquin Valley	2010 Base Run	9,800	27,600
	2010 Testing Scenario	10,200	25,200
	Percent Change	4%	-9%
Rest of State	2010 Base Run	31,100	79,600
	2010 Testing Scenario	33,800	69,600
	Percent Change	9%	-13%
Statewide	2010 Base Run	93,300	208,600
	2010 Testing Scenario	98,900	183,200
	Percent Change	6%	-12%

Overall Response to Auto Operating Cost Change

Table 6.5 provides a look at the trip length frequency distribution for personal trips. Auto trips increase for shorter trips and decrease as the trip lengths increase, suggesting travelers are making shorter trips due to the higher cost per mile.

Table 6.5 Number of Person Trips, by Trip Length – Increased Auto Operating Costs Scenario

Thousands of Trips

	SDPTM						LDPTM		
Trip Length (Miles)	**0-4**	**5-9**	**10-14**	**15-24**	**25-49**	**50-99**	**100-199**	**200-499**	**500+**
2010 Base Run	79,690	30,860	14,220	10,390	4,070	560	170	130	2
2010 Testing Scenario	91,660	28,270	10,590	6,610	2,210	250	180	100	1
Percent Change	15%	-8%	-26%	-36%	-46%	-55%	6%	-23%	-26%

Figures 6.1 and 6.2 shows the geographic distribution of the change in vehicle trips on roadways across the state. Here, significant decreases (shown in red) in total volumes along major corridors and in urban areas where transit options are more available are evidenced. Table 6.6 provides the change in total VMT across the state, which shows an overall decrease in VMT (-20 percent).

Figure 6.2 Change in Total Daily Volume (Northern California) – Increased Auto Operating Costs Scenario

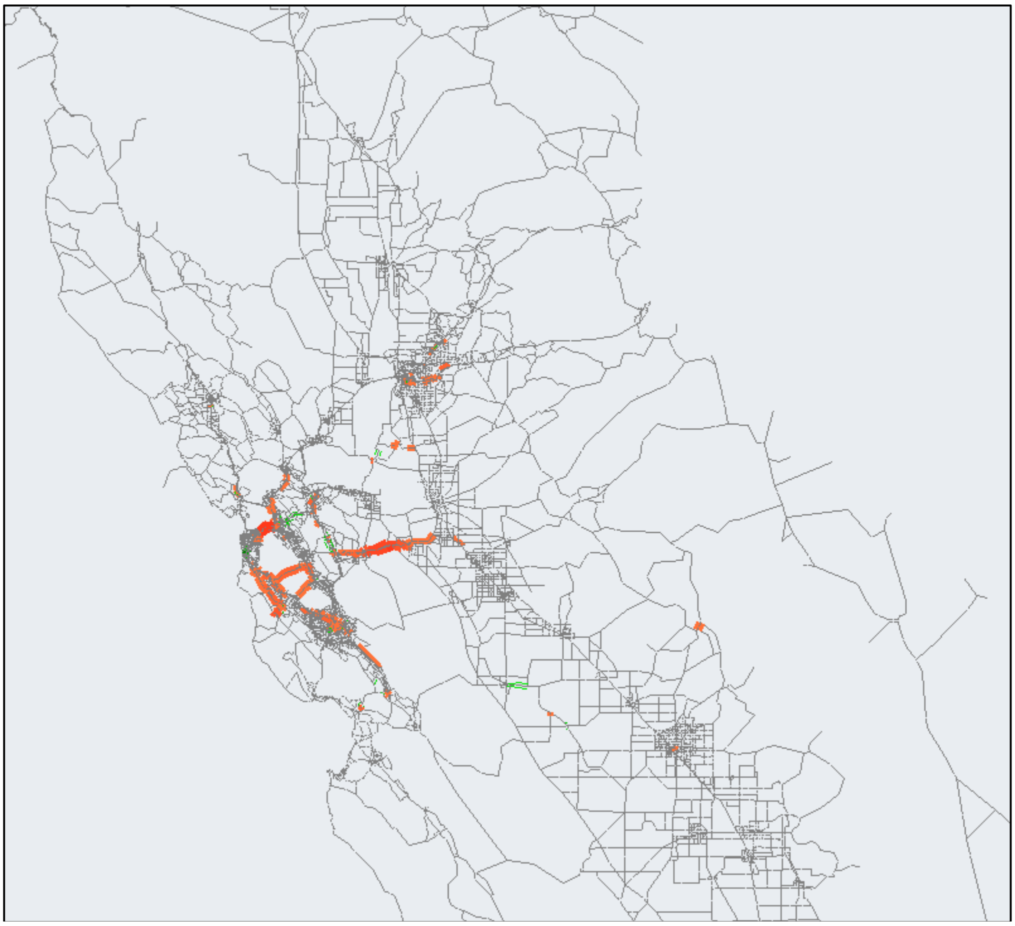


Figure 6.3 Change in Total Daily Volume (Southern California) – Increased Auto Operating Costs Scenario

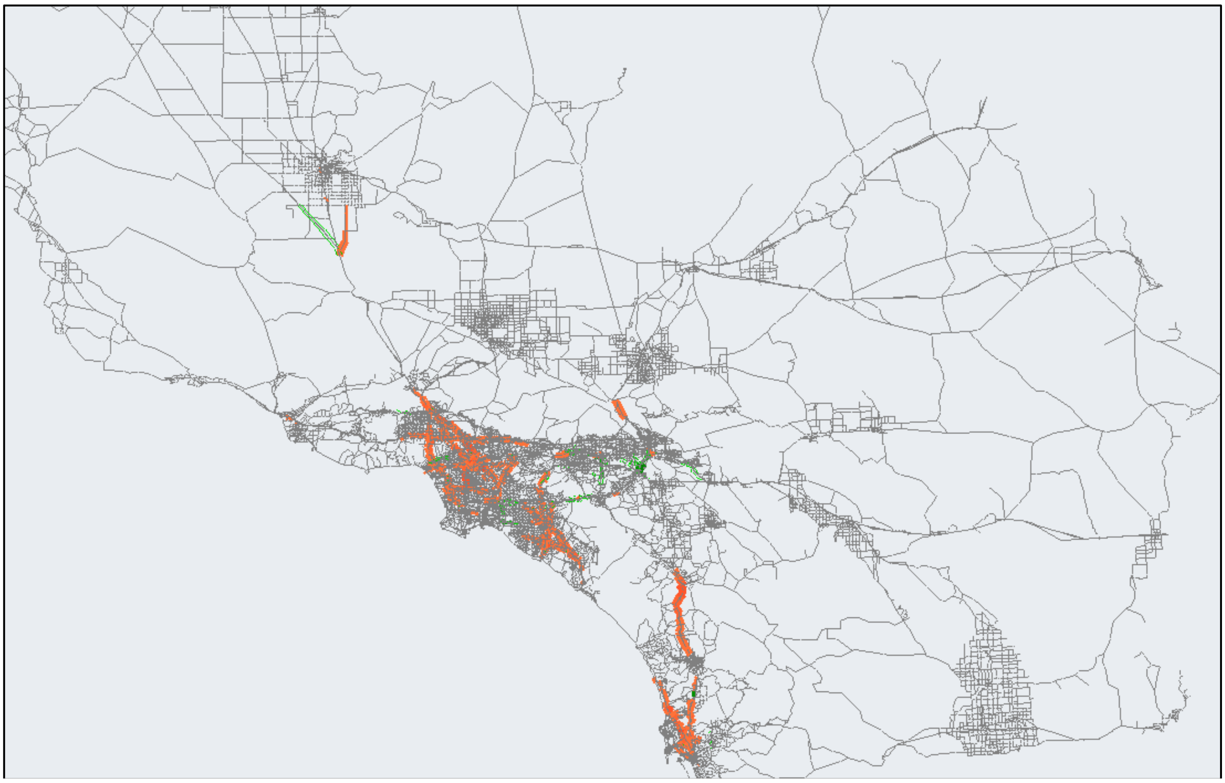


Table 6.6 Changes in Vehicle Miles of Travel – Increased Auto Operating Costs Scenario

	By Model					By Vehicle Type		Total (including Intrazonal)
Scenario	**SDPTM**	**LDPTM**	**SDCVM**	**LDCVM**	**ETM**	**Passenger Cars**	**Trucks**	
2010 Base Run	668,561	35,727	77,026	9,204	40,111	724,016	106,615	846,624
2010 Testing Scenario	507,291	29,390	67,682	9,195	40,025	556,432	97,151	674,713
Percent Change	-24%	-18%	-12%	0%	0%	-23%	-9%	-20%

6.3 Increased Transit Service

Two increases in service were selected for the Bay Area:

- Doubled local bus LOS for the entire Bay Area, and
- Doubled service (frequency) of all BART trains.

SDPTM Response to Network Change

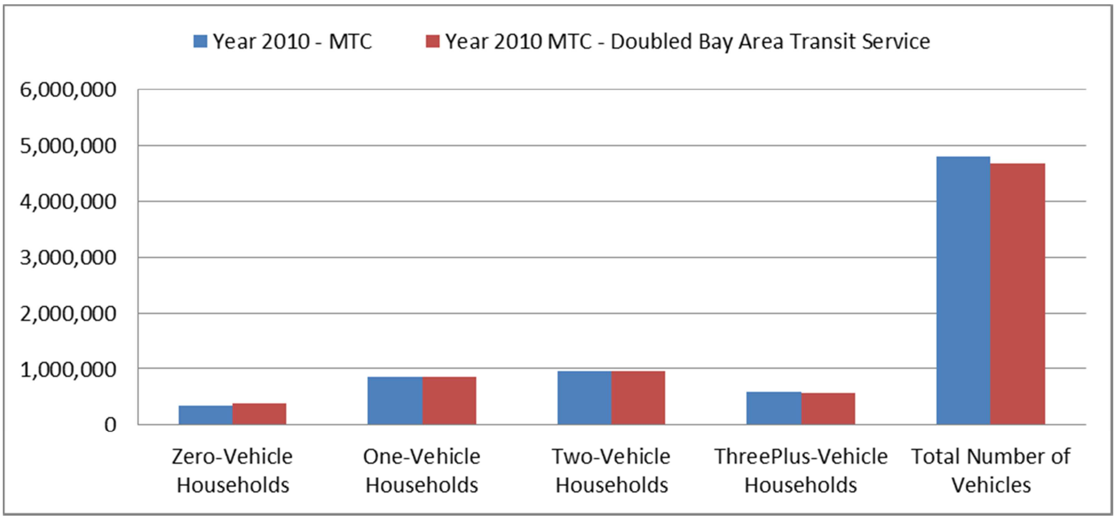
Auto Ownership

With an increase in transit service, the expected result would be a slight shift to fewer vehicles in the household. As shown in Table 6.7, the number of zero-vehicle households increased by 6 percent and a modest 1 percent decrease in total vehicles. Geographically, the changes were limited to the Bay Area, where changes were applied. Figure 6.4 shows the changes in number of household by vehicle ownership category as well as the difference between total number of vehicles in the region.

Table 6.7 Auto Ownership Shares by Region – Increase Transit Service Scenario

Geographic Area	Number of Households by Vehicle Ownership				Total Vehicles
	0 Vehicles	1 Vehicles	2 Vehicles	3+ Vehicles	
Far North	1%	0%	0%	-1%	0%
SACOG	0%	0%	0%	0%	0%
MTC	11%	0%	-1%	-4%	-2%
SJV	0%	0%	0%	0%	0%
W. Sierra Nevada	0%	0%	-1%	1%	0%
AMBAG	0%	0%	0%	1%	0%
Central Coast	0%	0%	0%	0%	0%
SCAG	0%	0%	0%	0%	0%
SANDAG	0%	0%	0%	0%	0%
Statewide	2%	0%	0%	-1%	0%

Figure 6.4 Number of Households by Auto Ownership and Total Vehicles in San Francisco Bay Area – Increase Transit Service Scenario



Trips by Mode

Table 6.8 shows essentially no change in the total number of trips but there were significant shifts toward transit, limited to the Bay Area.

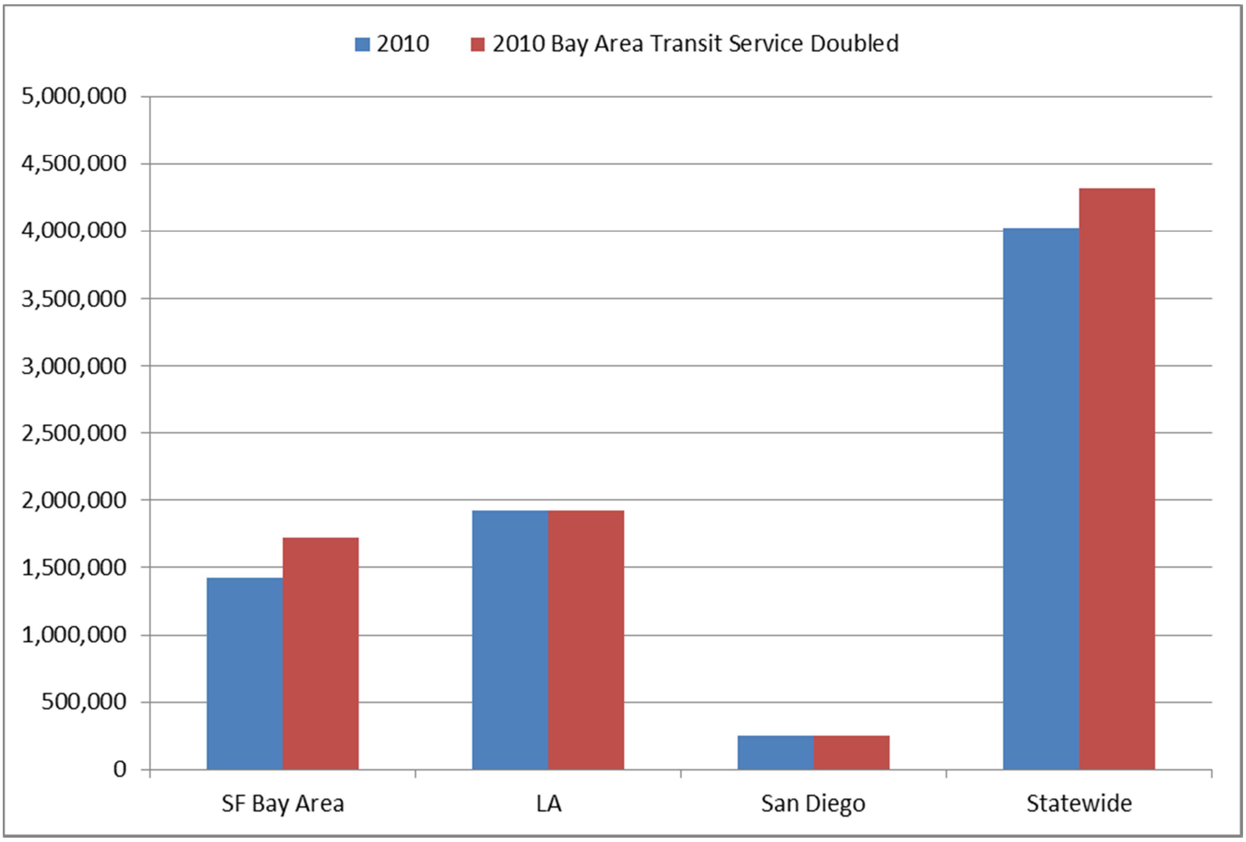
Table 6.8 SDPTM Person Trips by Mode – Increase Transit Service Scenario

Geographic Area	Scenario	SOV	HOV 2+	HOV 3+	Transit	Non-motorized	Total Trips
MTC	2010 Base Run	10,181,400	7,837,600	5,299,300	1,428,000	2,437,700	27,184,000
	2010 Testing Scenario	9,870,200	7,814,200	5,278,900	1,725,600	2,472,300	27,161,200
	Percent Change	-3%	0%	0%	21%	1%	0%
SCAG	2010 Base Run	24,858,700	20,061,800	14,796,600	1,987,400	5,507,500	67,212,000
	2010 Testing Scenario	24,867,800	20,074,200	14,806,200	1,990,200	5,496,400	67,234,800
	Percent Change	0%	0%	0%	0%	0%	0%
SJV	2010 Base Run	4,867,800	4,231,700	3,476,800	141,000	1,276,300	13,993,600
	2010 Testing Scenario	4,843,900	4,209,800	3,463,000	139,000	1,272,400	13,928,100
	Percent Change	0%	-1%	0%	-1%	0%	0%
Remainder	2010 Base Run	11,967,800	8,770,006	6,068,161	461,498	2,207,305	29,474,770
	2010 Testing Scenario	11,970,200	8,770,900	6,081,000	462,500	2,212,100	29,496,700
	Percent Change	0%	0%	0%	0%	0%	0%
Statewide	2010 Base Run	51,875,700	40,901,106	29,640,861	4,017,898	11,428,805	137,864,370
	2010 Testing Scenario	51,552,100	40,869,100	29,629,100	4,317,300	11,453,200	137,820,800
	Percent Change	-1%	0%	0%	7%	0%	0%

Transit Ridership

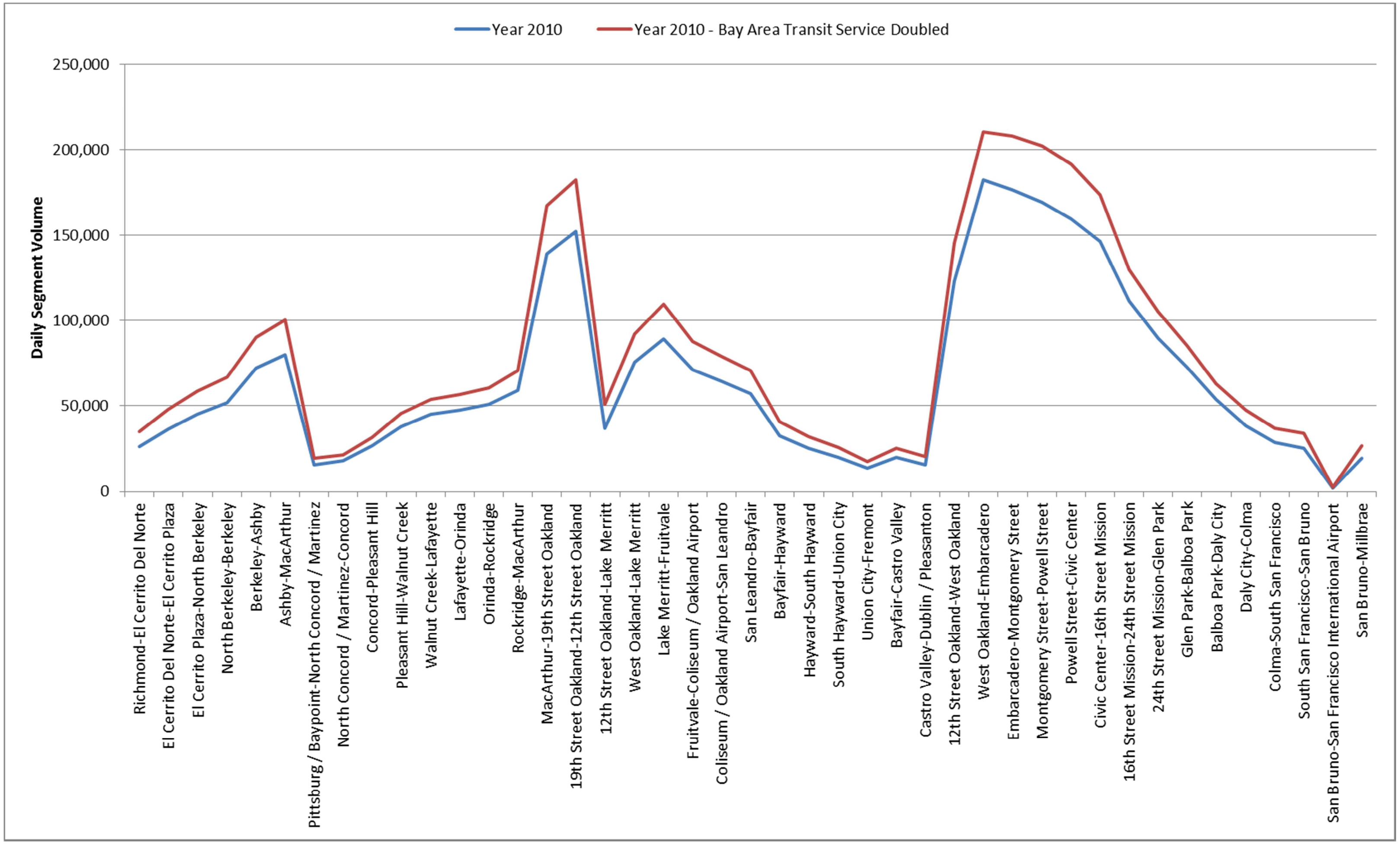
Transit trips were summarized by catchment area and revealed a 21-percent increase in transit riders for the Bay Area, as shown in Figure 6.5.

Figure 6.5 Transit Ridership – Increased Transit Service Scenario



Transit trips were also assigned to the network. Figure 6.6 shows the assigned BART trips for both scenarios, showing a stable increase in riders throughout the system.

Figure 6.6 BART Ridership – Increased Transit Service Scenario



LDPTM Response to Network Change

For the LDPTM, we would expect modest changes since the tested service changes are regional services and would like not have an affect on long-distance trip choices.

Trips by Mode

Table 6.9 shows virtually no change in person trips across the state, with a small decrease in auto trips originating in the Bay Area. Note that percent changes that seem high actually reflect a small difference in number of trips.

Table 6.9 LDPTM Person Trips by Mode – Increase Transit Service Scenario

Geographic Area	Scenario	SOV	HOV 2+	HOV 3+	Rail	Air	Total Trips
MTC	2010 Base Run	13,500	14,700	15,300	400	13,100	57,000
	2010 Testing Scenario	13,400	14,700	15,400	400	13,000	56,900
	Percent Change	-1%	0%	1%	0%	-1%	0%
SCAG	2010 Base Run	26,800	26,300	28,400	1,400	12,600	95,500
	2010 Testing Scenario	26,800	26,100	28,800	1,300	12,400	95,400
	Percent Change	0%	-1%	1%	-7%	-2%	0%
SJV	2010 Base Run	11,200	12,000	13,200	700	300	37,400
	2010 Testing Scenario	11,100	11,600	13,300	800	300	37,100
	Percent Change	-1%	-3%	1%	14%	0%	-1%
Remainder	2010 Base Run	33,100	34,500	32,600	1,800	7,200	109,200
	2010 Testing Scenario	32,700	34,300	32,500	1,600	7,300	108,400
	Percent Change	-1%	-1%	0%	-11%	1%	-1%
Statewide	2010 Base Run	84,600	87,500	89,500	4,300	33,200	299,100
	2010 Testing Scenario	84,000	86,700	90,000	4,100	33,000	297,800
	Percent Change	-1%	-1%	1%	-5%	-1%	0%

Trips by Purpose

Table 6.5 provides the change in trips by purpose for the LDPTM. Percent changes for business/commute trips are shown to be more sensitive to changes in service.

Table 6.10 LDPTM Person Trips by Trip Purpose – Increase Transit Service Scenario

Geographic Area	Scenario	Business/ Commute	Recreation/ Other
MTC	2010 Base Run	20,500	36,400
	2010 Testing Scenario	20,500	36,400
	Percent Change	0%	0%
SCAG	2010 Base Run	31,800	63,700
	2010 Testing Scenario	32,100	63,400
	Percent Change	1%	0%
SJV	2010 Base Run	9,900	27,400
	2010 Testing Scenario	9,600	27,400
	Percent Change	-3%	0%
Remainder	2010 Base Run	31,100	78,300
	2010 Testing Scenario	31,100	77,400
	Percent Change	0%	-1%
Statewide	2010 Base Run	93,300	205,800
	2010 Testing Scenario	93,300	204,600
	Percent Change	0%	-1%

Overall Response to Network Change

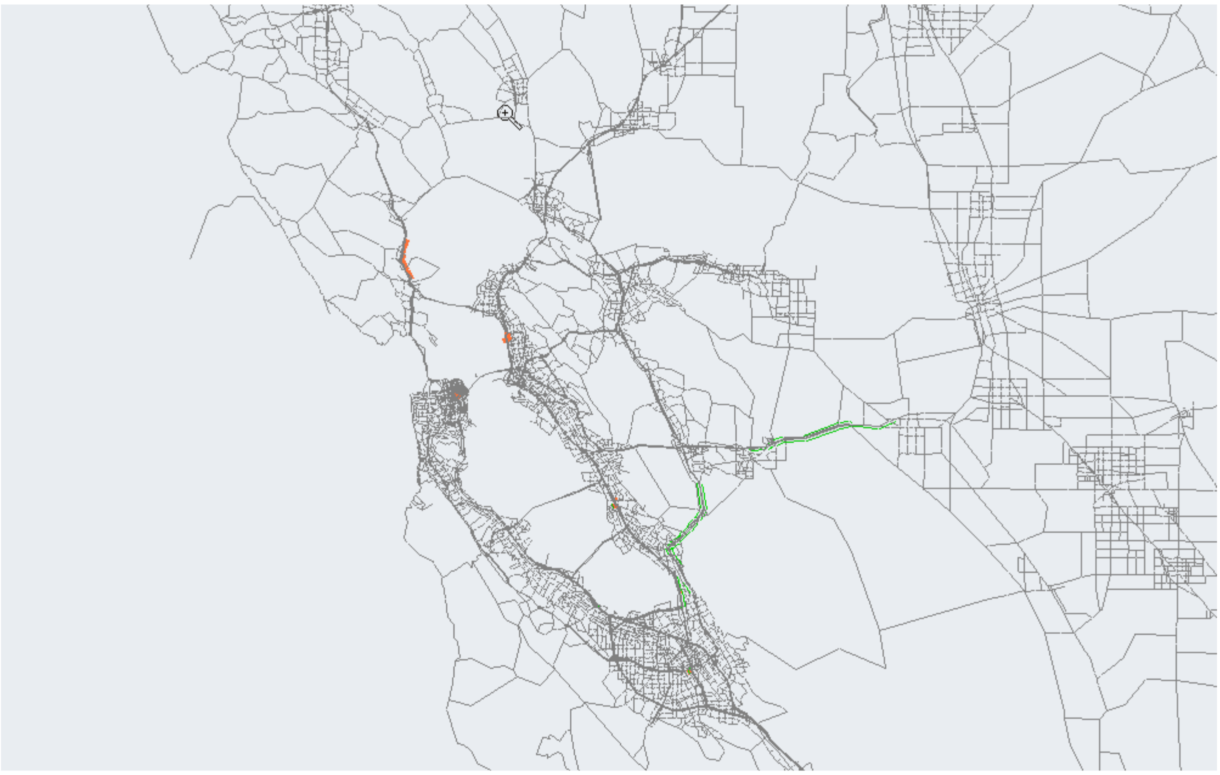
Table 6.11 provides a look at the trip length distribution for personal trips. With fewer drivers on the road and less congestion, travelers are making longer trips.

Table 6.11 Number of Person Trips, by Trip Length – Increased Transit Service Scenario

	SDPTM						LDPTM		
Trip Length (Miles)	**0-4**	**5-9**	**10-14**	**15-24**	**25-49**	**50-99**	**100-199**	**200-499**	**500+**
2010 Base Run	81,216,200	30,592,600	13,779,300	9,888,800	3,790,500	512,400	175,075	122,226	1,737
2010 Testing Scenario	81,045,400	30,529,800	13,795,200	9,949,700	3,881,400	540,400	174,123	121,926	1,808
Percent Change	0%	0%	0%	1%	2%	5%	-1%	0%	4%

Figures 6.7 and 6.8 shows the geographic distribution of the change in vehicle trips on roadways across the state, which shows some little difference of total volume in the Bay Area. Changes in volume could be attributed to simulation noise or model convergence in congested corridors. Table 6.12 provides the change in total VMT across the state, which shows essentially no change in VMT.

Figure 6.7 Change in Total Daily Roadway Volume (Northern California) – Increased Transit Service Scenario



Red = decreased roadway volumes; Green = increased roadway volumes.

Figure 6.8 Change in Total Daily Roadway Volume (Southern California) – Increased Transit Service Scenario

Red = decreased roadway volumes; Green = increased roadway volumes.

Table 6.12 Changes in VMT – Increased Transit Service Scenario

	By Model					By Vehicle Type		Total
Scenario	**SDPTM**	**LDPTM**	**SDCVM**	**LDCVM**	**ETM**	**Passenger Cars**	**Trucks**	**(Including Intrazonal)**
2010 Base Run	649,555	34,491	75,519	9,201	39,239	704,397	103,609	824,707
2010 Testing Scenario	650,127	34,407	75,852	9,201	39,139	704,884	103,843	825,340
Percent Change	0%	0%	0%	0%	0%	0%	0%	0%

7.0 Summary

This report has included four areas of model performance evaluation – basic reasonableness tests, base year model validation, Year 2010 backcast, and sensitivity tests.

Reasonableness checks were conducted to compare congested highway travel times against travel times from Google Maps. Modeled long distance city-to-city travel times matched closely with Google Maps; in all but one case, the modeled travel times were within four percent of examined Google Maps times.

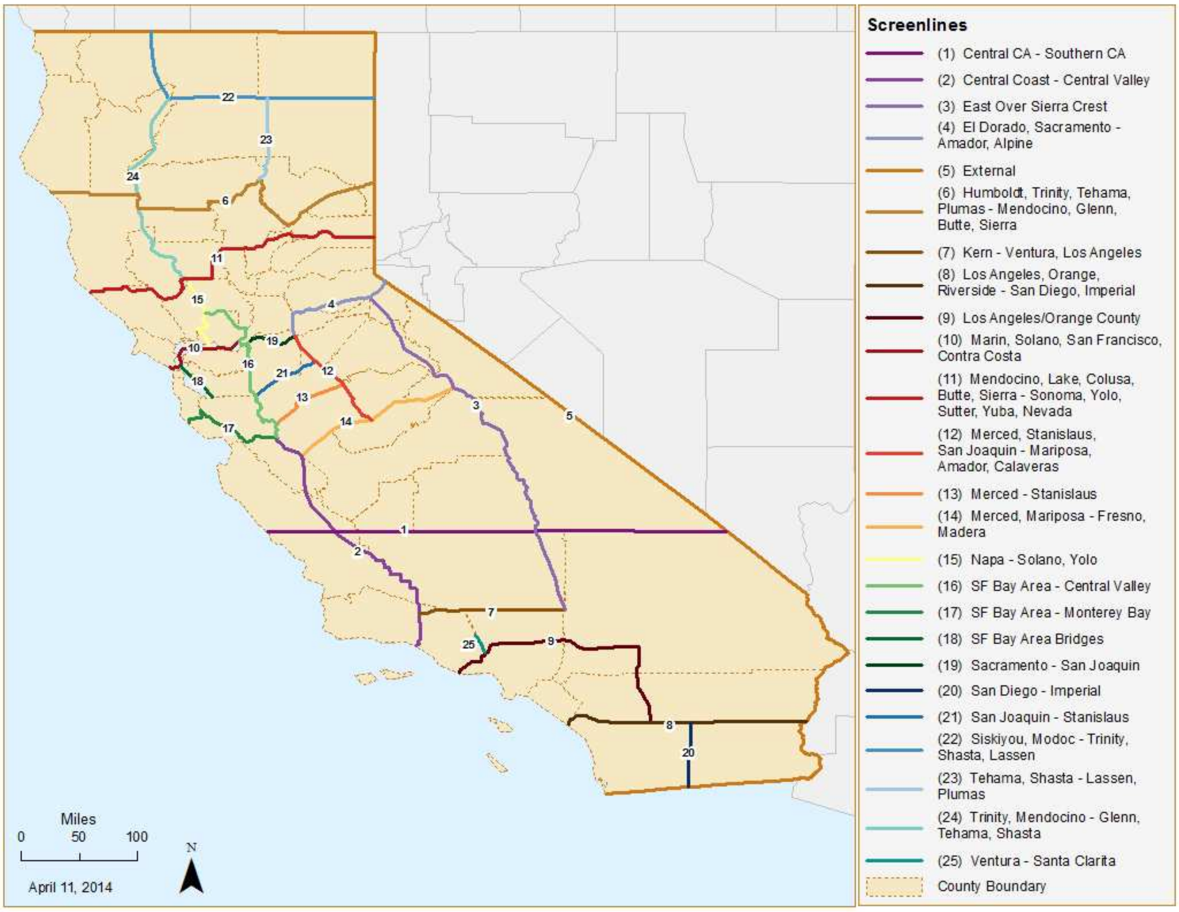
Validation tests for the Year 2010 base year revealed reasonable VMT, travel times, and congested speeds. At interregional borders and key corridors of travel, estimated vehicle volumes matched observed fairly well. However, some locations within the Bay Area, primarily to/from San Francisco, were under-estimated. In general, traffic volumes at screenlines are lower than observed traffic volumes, with the most notable differences occurring in the San Francisco Bay Area. The reasons why the model under-predicts screenline traffic are not fully understood. Given the complexity of traffic patterns and with the five different components of the model system, we suggest that additional data collection could help provide more insights on why traffic is somewhat underpredicted compared with observed data.

The Year 2000 backcast revealed reasonable sensitivities in the model and forecasting abilities, given revealed changes in land use, costs, and the transportation network. The Year 2010 model actually performed slightly better than the 2010 calibration year. The backcast proved a useful exercise in understanding model performance.

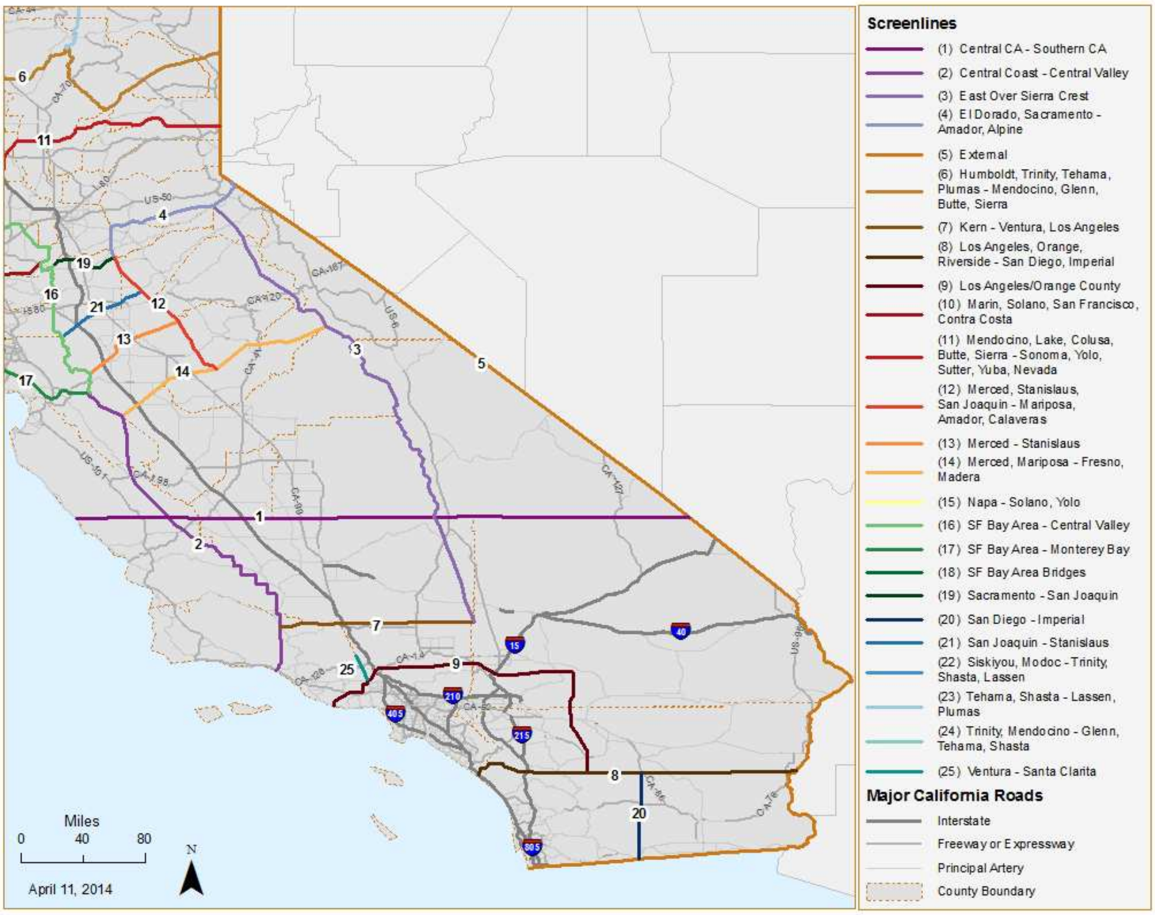
Sensitivity tests include increases to auto operating costs and increased transit services. The sensitivity testing revealed that the SDTPM tour generation model is not sensitive to changes in cost but mode choice and trip length do show changes intuitive to increases in auto cost. Changes in transit service also revealed changes in mode choice and trip length.

The LDPTM trip frequency, mode choice, and destination choice models showed decreases in total number of trips, shifts to non-auto modes, and shorter trips with increased auto operating costs. Increases in transit service revealed little to no change in the LDPTM trip characteristics, as would be expected given that the transit service changes were limited to within a region.

A. Screenline Definitions




Screenlines
(1) Central CA - Southern CA
(2) Central Coast - Central Valley
(3) East Over Sierra Crest
(4) El Dorado, Sacramento - Amador, Alpine
(5) External
(6) Humboldt, Trinity, Tehama, Plumas - Mendocino, Glenn, Butte, Sierra
(7) Kern - Ventura, Los Angeles
(8) Los Angeles, Orange, Riverside - San Diego, Imperial
(9) Los Angeles/Orange County
(10) Marin, Solano, San Francisco, Contra Costa
(11) Mendocino, Lake, Colusa, Butte, Sierra - Sonoma, Yolo, Sutter, Yuba, Nevada
(12) Merced, Stanislaus, San Joaquin - Mariposa, Amador, Calaveras
(13) Merced - Stanislaus
(14) Merced, Mariposa - Fresno, Madera
(15) Napa - Solano, Yolo
(16) SF Bay Area - Central Valley
(17) SF Bay Area - Monterey Bay
(18) SF Bay Area Bridges
(19) Sacramento - San Joaquin
(20) San Diego - Imperial
(21) San Joaquin - Stanislaus
(22) Siskiyou, Modoc - Trinity, Shasta, Lassen
(23) Tehama, Shasta - Lassen, Plumas
(24) Trinity, Mendocino - Glenn, Tehama, Shasta
(25) Ventura - Santa Clarita
Major California Roads
Interstate
Freeway or Expressway
Principal Artery
County Boundary
US-199
US-97
CA-139
CA-89
US-395
CA-299
CA-44
CA-70
US-101
CA-20
I-80
US-50
CA-167
CA-120
I-580
I-280
CA-41
CA-198
CA-99
5
Miles
0 30 60
N
April 11, 2014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(1) Central CA - Southern CA
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(12) Merced, Stanislaus, San Joaquin - Mariposa, Amador, Calaveras
(13) Merced - Stanislaus
(14) Merced, Mariposa - Fresno, Madera
(15) Napa - Solano, Yolo
(16) SF Bay Area - Central Valley
(17) SF Bay Area - Monterey Bay
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(19) Sacramento - San Joaquin
(20) San Diego - Imperial
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(22) Siskiyou, Modoc - Trinity, Shasta, Lassen
(23) Tehama, Shasta - Lassen, Plumas
(24) Trinity, Mendocino - Glenn, Tehama, Shasta
(25) Ventura - Santa Clarita
Major California Roads
Interstate
Freeway or Expressway
Principal Artery
County Boundary
Miles
0 40 80
N
April 11, 2014

B. Screenline Lookup Table

Screenline	Caltrans or PeMS ID	County	Route	Post Mile	Location
1	273	SLO	1	71.341	San Carpojo Creek
1	203	KIN	5	16.565	Jct Rte 41
1	58	KIN	33	7.8	Reef City, Jct Rte 41
1	652	KER	43	33.48	Pond Rd/Wasco Ave
1	606	TUL	65	14.073	Avenue 112
1	91	KER	99	52.45	Pond Rd
1	552	SLO	101	69.322	San Luis Obispo/Monterey County Line
1	955	INY	127	0	San Bernardino/Inyo County Line
1	700	INY	395	29.432	Jct Rte 190
2	243	SLO	41	42.172	Jct Rte 46
2	71	KER	58	15.41	Jct Rte 33
2	501	SB	101	0.634	Jct Rte 150 East
2	154	MON	198	13.995	Jct Rte 25 North
3	303	CAL	4	60.048	Cabbage Patch Maintenance Station
3	139	ALP	88	13.4	Picketts, West Jct Rte 89
3	172	TUO	108	57.909	Kennedy Meadows Rd
3	948	MNO	120	12.056	Jct Rte 395
4	84	AMA	16	9.093	Jct Rte 124 South
4	653	ED	89	0	Alpine/El Dorado County Line
4	708	SAC	104	12.183	Rancho Seco Rd
4	1012310/ 1012210	AMA	49	4.32	Jackson, Main/Mattley St
5	501	SD	5	0.878	South Jct Rte 805
5	231	SIS	5	68.328	Hilt Rd
5	997	MNO	6	32.29	Nevada State Line
5	607	IMP	7	1.188	Calexico, Jct Rte 98
5	988	IMP	8	96.986	Arizona State Line
5	909	RIV	10	156.492	Arizona State Line
5	907	SBD	15	138.456	East Baker
5	166	PLA	28	11	Cal-Neva Drive

Screenline	Caltrans or PeMS ID	County	Route	Post Mile	Location
5	885	SBD	40	154.643	Arizona State Line
5	387	ED	50	80.439	South Lake Tahoe, Nevada State Line
5	495	NEV	80	29.489	Farad
5	42	ALP	88	22.668	Diamond Valley Rd
5	848	SBD	95	9.684	Jct Rte 62
5	290	SIS	97	53.809	Jct Rt 161 East
5	807	DN	101	45.89	Oregon State Line
5	708	IMP	111	0.202	Second St
5	925	INY	127	42.149	Jct Rte 190 West
5	145	SIS	139	5.043	Oregon State Line, Jct Rte 161 West
5	602	MNO	167	21.331	Nevada State Line
5	943	MNO	168	1.45	Oasis, Jct Rte 226 North
5	637	INY	178	62.186	Nevada State Line
5	514	MNO	182	5.22	Bridgeport Reservoir
5	943	IMP	186	2.07	Jct Rte 8
5	950	SD	188	1.85	Jct Rte 94
5	991	MNO	395	120.49	Nevada State Line
5	215	LAS	395	4.615	Jct Rte 70 West
5	178	MOD	395	28.285	Jct Rte 299 East
5	127	SD	905	11.366	Siempre Viva Rd OC
6	95	GLE	5	27.812	County Rd 7
6	180	BUT	32	25.822	Lomo, Humboldt Rd
6	199	BUT	70	42.08	Pulga-Mill Creek Maintenance Station
6	200	PLU	70	45.245	Quincy State Highway Maintenance Station
6	182	TEH	99	0	Butte/Tehama County Line
6	142	HUM	101	0.19	Mendocino/Humboldt County Line
6	289	LAS	395	29.84	Garnier Rd
7	631	KER	5	13.523	Wheeler Ridge Rd
7	927	KER	14	0	Avenue A, LA/Kern County Line
7	233	SLO	33	2.802	Jct Rte 166 West
8	401	ORA	5	0.483	Concordia School Rd
8	917	SD	15	54.07	Rainbow Valley Blvd
8	844	IMP	78	80.743	Palo Verde, Imperial/Riverside County Line
8	845	SD	79	53.035	San Diego/Riverside County Line

Screenline	Caltrans or PeMS ID	County	Route	Post Mile	Location
8	962	IMP	86	63.63	Salton Sea Beach Rd
8	709	IMP	111	57.625	Bombay Beach Rd
9	427	VEN	1	0	LA/Ventura County Line
9	751	LA	5	44.5	South of Jct Rte 14
9	808	RIV	10	8.336	College Ave
9	900	SBD	15	32.323	Joshua St/Palm Ave
9	203	LA	101	36.18	Agoura Hills, Reyes Adobe Rd Interchange
9	444	LA	118	1.19	LA/Ventura County Line
9	224	LA	138	69.3	Jct Rte 18, Palmdale Rd
10	504	CC	580	6.13	Richmond-San Rafael Bridge
10	402554/ 402553		101		North of Golden Gate Bridge
10	400337/ 400829		80		Carquinez Bridge
10	402153/ 402466		680		Benicia-Martinez Bridge
11	180	MEN	1	2.5	Sonoma/Mendocino County Line
11	80	YOL	5	22.61	Jct Rte 505 South
11	104	YOL	16	18.132	Mossy Creek Bridge
11	355	SUT	20	0	Colusa/Sutter County Line
11	81	NAP	29	37.902	Calistoga, Silverado Trail
11	340	YUB	70	35.5417	Dixon/Grant Rd
11	663	SIE	89	15.055	Sierraville Jct Rte 49 north
11	305	BUT	99	0	Sutter/Butte County Line
11	86	SON	101	51.617	Citrus Fair Dr
11	Caltrans Count Book	SON	128	4.859	JCT RTE 101U/N CLOVERDALE
12	91	CAL	12	9.927	Valley Springs, Jct Rte 26 South
12	244	CAL	26	4.379	Jenny Lind Rd
12	420	TUO	120	5.982	Kistler Ranch Uc
12	71	STA	132	51.006	Stanislaus/Tuolumne County Line
12	36	MPA	140	9.5	Hornitos Rd
13	285	MER	5	23.6	North of Route 33 @ Santa Nella Truck Scales
13	320	MER	99	34.429	Shanks Rd
13	324	STA	165	1.45	Jct Rte 99

Screenline	Caltrans or PeMS ID	County	Route	Post Mile	Location
14	851	FRE	5	48.99	Panoche Rd
14	62	FRE	33	79.905	Brannon Ave
14	620	MAD	41	35.77	Oakhurst, Rd 426
14	93	MPA	49	0	Madera/Mariposa County Line
14	92	MAD	99	26.576	Jct Rte 233 West
14	152	MAD	152	1.07	County Rd 4/Lincoln Rd
15	Caltrans Count Book	NAP	29	3.61	Kelly Rd South
15	Caltrans Count Book	NAP	12		
15	730	YOL	128	4.637	County Rd 86
16	12	SJ	4	4.421	Middle River Bridge
16	346	YOL	80	0	Solano/Yolo County Line
16	645	YOL	84	0	Solano/Yolo County Line
16	248	MER	152	0	Santa Clara/Merced County Line
16	816	SAC	160	5.95	Sacramento River, Isleton Bridge
16	1028310/ 1028410	SJ	12		Just west of I-5
16	76	SJ	205	0	Alameda/San Joaquin County Line
16	903	SOL	505	3.058	Midway Rd
16	9	SJ	580	15.34	San Joaquin/Alameda County Line
17	Caltrans Count Book	SCR	1	0	Solano/Napa County Line
17	170	SCL	9	7.09	Saratoga, Sixth St
17	550	SCR	17	5.453	Granite Creek Rd
17	58	SCL	101	3.197	Jct Rte 25 East
17	Caltrans Count Book	SCL	152	0	Santa Cruz/Santa Clara County Line
17	712	SBT	156	18.43	San Benito/Santa Clara County Line
18	500	ALA	80	1.989	Bay Bridge
18	400071/ 400683				San Mateo Bridge
18	506	ALA	84	0	Dumbarton Bridge
19	24	SJ	5	44.712	Peltier Rd
19	500	SAC	99	0.123	San Joaquin/Sacramento County Line
20	981	SD	8	65.904	Jct Rte 94 South

Screenline	Caltrans or PeMS ID	County	Route	Post Mile	Location
20	973	SD	78	70.01	San Felipe Rd
21	79/ 10150	STA	5	28.055	Stanislaus/San Joaquin County Line
21	198	SJ	33	4.826	Jct Rte 5
21	4	SJ	99	2.374	Jacktone Rd
21	2	SJ	120	21.18	San Joaquin/Stanislaus County Line
21	219	STA	132	13.42	Modesto, Carpenter Rd
22	237	SIS	3	44.67	Forest Mountain Ranch
22	242	SHA	89	30	Lake Britton
22	137	SIS	96	103.418	Jct Rt 263 South
22	144	MOD	139	0.231	Jct Rte 299
22	165	SHA	299	9.34	Kings Beach, Jct Rte 267 North
22	246	MOD	395	3.216	Likely, Jess Valley Rd
23	225	TEH	36	82.205	Mineral Maintenance Station
23	139	LAS	44	19.29	County Road A 21
24	124	COL	20	3.451	Jct Rte 16 South
24	192	TRI	36	28.65	Jct Rte 3 North
24	159	TRI	299	72.246	Trinity/Shasta County Line
25	462	LA	126	3.564	Wolcott Way
26	908	RIV	10	43.43	Jct Rte 39, Beach Blvd
26	327	SOL	37	1.69	Skaggs Island Rd
26	68	SLO	46	55.106	Jct Rte 41 Northeast
26	125	LAS	70	3.889	Jct Rte 395
26	152	SIS	161	19.361	Jct Rte 139
26	170	MOD	299	40.63	Alturas, Jct Rte 395